



---

## Hill Air Force Base, Utah

---

Final

**Operable Unit 11  
Record of Decision**

---

JUNE 2015

REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. <b>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.</b>					
1. REPORT DATE (DD-MM-YYYY) 17-08-2015		2. REPORT TYPE Final		3. DATES COVERED (From - To) Not applicable	
4. TITLE AND SUBTITLE Operable Unit 11 Record of Decision Hill Air Force Base, Utah				5a. CONTRACT NUMBER FA8903-09-D-8560-0006	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) EA Engineering, Science, and Technology, Inc., PBC				5d. PROJECT NUMBER 6236906	
				5e. TASK NUMBER 0006	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) EA Engineering, Science, and Technology, Inc., PBC 2363 N. Hill Field Road, Suite 104 Layton, Utah 84041				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Civil Engineer Center 2261 Hughes Avenue, Suite 163 JBSA Lackland Air Force Base, Texas 78236-9853				10. SPONSOR/MONITOR'S ACRONYM(S) AFCEC	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT This Record of Decision describes the selected remedy for cleanup of groundwater at Operable Unit 11 at Hill Air Force Base in Davis County, Utah. The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986; and the National Oil and Hazardous Substances Pollution Contingency Act. The selected remedy is Alternative 3: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Mass Removal, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes.					
15. SUBJECT TERMS Groundwater, in situ, Record of Decision, underground storage tank, containment					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT  ABSTRACT	18. NUMBER OF PAGES  152	19a. NAME OF RESPONSIBLE PERSON Sandra Staigerwald
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code) (385) 393-4982



# *Hill Air Force Base Performance-Based Remediation*

## Operable Unit 11 Record of Decision

Contract No: FA8903-09-D-8560  
Task Order 0006

Prepared for:  
Air Force Civil Engineer Center  
2261 Hughes Avenue, Suite 163  
JBSA Lackland Air Force Base, Texas 78236-9853

Prepared by:  
EA Engineering, Science, and Technology, Inc., PBC  
2363 N. Hill Field Road, Suite 104  
Layton, Utah 84041

JUNE 2015

**THIS PAGE INTENTIONALLY LEFT BLANK**

# Contents

	<u>Page</u>
Tables .....	v
Figures .....	v
Appendices.....	v
Acronyms and Abbreviations .....	vii
Declaration for the Record of Decision .....	1
Site Name and Location.....	1
Statement of Basis and Purpose.....	1
Assessment of the Site .....	1
Description of Selected Remedy.....	1
Statutory Determinations .....	2
Data Certification Checklist.....	3
Authorizing Signatures and Support Agency Acceptance of Remedy .....	3
1.0 Site Name, Location, and Description .....	1-1
2.0 Site History and Enforcement Activities .....	2-1
2.1 History of Site Activities .....	2-1
2.1.1 History of Hill Air Force Base.....	2-1
2.1.2 CERCLA Regulatory History .....	2-1
2.1.3 Federal Facility Agreement .....	2-2
2.2 Description and History of Operable Unit 11 .....	2-2
2.2.1 History of the Operable Unit 11 Area.....	2-2
2.2.2 Source Areas .....	2-3
2.3 Investigation History of Operable Unit 11.....	2-3
2.3.1 UST Site 454 Investigations .....	2-3
2.3.2 Operable Unit 11 Remedial Investigation.....	2-4
2.3.3 Soil Gas Investigation.....	2-5
2.4 Remedial Actions.....	2-6
2.5 Highlights of Community Participation.....	2-7
2.6 Scope and Role of the Operable Unit 11 Response Action .....	2-7
3.0 Site Characteristics.....	3-1
3.1 Physical Setting.....	3-1

3.1.1	Physiography .....	3-1
3.1.2	Topography .....	3-1
3.1.3	Geology.....	3-1
3.1.4	Hydrogeology .....	3-2
3.2	Nature and Extent of Contamination .....	3-2
3.2.1	Soil Contamination .....	3-3
3.2.2	Light Non-Aqueous Phase Liquid .....	3-3
3.2.3	Dissolved Plumes.....	3-3
3.3	Fate and Transport of Contaminants.....	3-5
3.3.1	Contaminant Migration.....	3-5
3.3.2	Thiessen Polygon Plume Mass Evaluation .....	3-5
3.3.3	Natural Attenuation Evaluation .....	3-6
3.3.4	Groundwater Flow and Transport Modeling .....	3-8
3.4	Current and Potential Future Land and Resources Uses.....	3-9
3.4.1	Current Land and Water Use .....	3-9
3.4.2	Potential Future Land and Water Use.....	3-9
4.0	Summary of Site Risks.....	4-1
4.1	Human Health Risk Assessment .....	4-1
4.1.1	Identification of Contaminants of Potential Concern .....	4-1
4.1.2	Exposure Assessment .....	4-1
4.1.3	Toxicity Assessment.....	4-2
4.1.4	Summary of Risk Characterization.....	4-3
4.1.4.1	Current Risks .....	4-4
4.1.4.2	Future Risks .....	4-5
4.2	Ecological Risks .....	4-5
4.3	Uncertainty Analysis.....	4-5
4.4	Overview of Site Risks .....	4-6
5.0	Remedial Action Objectives .....	5-1
5.1	RAO 1 .....	5-1
5.2	RAO 2 .....	5-1
5.3	RAO 3 .....	5-2
5.4	RAO 4 .....	5-2
6.0	Description of Remedial Alternatives.....	6-1
6.1	Common Elements of Remedial Alternatives.....	6-1
6.1.1	Institutional Controls .....	6-1
6.1.2	Monitored Natural Attenuation.....	6-3

6.1.3	Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery	6-4
6.2	Description of Alternatives .....	6-4
6.2.1	Alternative 1: No Action.....	6-4
6.2.2	Alternative 2: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Monitored Natural Attenuation and Institutional Controls for the Dissolved-Phase Plumes .....	6-4
6.2.3	Alternative 3: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Mass Removal, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes .....	6-5
6.2.4	Alternative 4: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Enhanced Aerobic Biodegradation, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes .....	6-7
6.2.5	Alternative 5: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; In Situ Chemical Oxidation, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes	6-8
6.3	Distinguishing Features of Alternatives.....	6-9
7.0	Summary of the Comparative Analysis of Remedial Alternatives .....	7-1
7.1	Summary of the Evaluation Criteria .....	7-1
7.2	Comparative Analysis of the Alternatives .....	7-2
7.2.1	Overall Protection of Human Health and the Environment (Protectiveness) .....	7-2
7.2.2	Compliance with Applicable or Relevant and Appropriate Requirements.....	7-2
7.2.3	Long-Term Effectiveness and Permanence .....	7-2
7.2.4	Reduction of Toxicity, Mobility, or Volume through Treatment .....	7-3
7.2.5	Short-Term Effectiveness .....	7-3
7.2.6	Implementability.....	7-4
7.2.7	Cost.....	7-4
7.2.8	State/Support Agency Acceptance.....	7-4
7.2.9	Community Acceptance.....	7-4
7.3	Principal Threat Wastes .....	7-4
8.0	Selected Remedy.....	8-1
8.1	Description of the Selected Remedy.....	8-1
8.1.1	Source Area Remediation .....	8-1
8.1.2	Dissolved Plume Remediation.....	8-1
8.1.3	Performance Monitoring.....	8-2
8.1.4	Institutional Controls .....	8-2
8.1.5	Remedial Timeframe and Cost .....	8-3
8.2	Statutory Determinations .....	8-4
8.2.1	Protection of Human Health and the Environment.....	8-4

8.2.2	Compliance with Applicable or Relevant and Appropriate Requirements .....	8-4
8.2.3	Cost Effectiveness.....	8-4
8.2.4	Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable.....	8-5
8.2.5	Preference for Treatment as a Principal Element .....	8-5
8.2.6	Five-Year Review Requirements .....	8-5
8.3	Documentation of Significant Changes .....	8-6
9.0	Responsiveness Summary.....	9-1
9.1	Overview.....	9-1
9.2	Background on Community Involvement.....	9-1
9.3	Summary of the Public Meeting and Public Comments .....	9-1
10.0	References.....	10-1

## Tables

4-1	Remedial Investigation Risk Assessment Summary
4-2	Chemical-Specific Cumulative Risks in Groundwater
4-3	Summary of Groundwater Constituents Detection Frequency
4-4	Summary of Cumulative Human Health Risks
5-1	Remediation Goals for Principal Contaminants of Concern in Groundwater
6-1	Distinguishing Features of Alternatives
7-1	Comparative Analysis of Alternatives
8-1	Estimated Cost Summary for Selected Remedy Implementation

## Figures

1-1	Site Location Map
1-2	Site Features
1-3	Groundwater Plumes
2-1	Soil Vapor Extraction and Monitoring Well Locations
3-1	Cross Section A-A' with MTBE, TCE, and Benzene Plumes
3-2	Potentiometric Surface for the Shallow Aquifer and Location of Cross Section A-A'
3-3	LNAPL Extent and Groundwater Plume Map – TCE and Benzene
3-4	Groundwater Plume Map – MTBE
3-5	Thiessen Polygon Plume Mass Analysis
4-1	Exposure Model Diagram
6-1	Alternative 3 – SVE and Manual Recovery for the Source Area; Mass Removal, MNA, and ICs for the Dissolved-Phase Plumes
6-2	Alternative 4 – SVE and Manual Recovery for the Source Area; Enhanced Aerobic Biodegradation, MNA, and ICs for the Dissolved-Phase Plumes
6-3	Alternative 5 – SVE and Manual Recovery for the Source Area; ISCO, MNA, and ICs for the Dissolved-Phase Plumes

## Appendices

A	Applicable or Relevant and Appropriate Requirements Tables
B	Proposed Plan Comments and U.S. Air Force Responses to Comments

**THIS PAGE INTENTIONALLY LEFT BLANK**



# Acronyms and Abbreviations

---

75 CEG/CEV	Environmental Management Division
µg/kg	Microgram(s) per kilogram
µg/L	Microgram(s) per liter
AFB	Air Force Base
AFCEC/CZOM	Air Force Civil Engineer Center/Environmental Operations Midwest Region Branch
AFCEC/CZ	Air Force Civil Engineer Center/Environmental Directorate
AFLOA/JACE	Air Force Legal Operations Agency, Environmental Law and Litigations Division
ARAR	Applicable or relevant and appropriate requirement
ARGC	Automated Geographic Reference Center
bgs	Below ground surface
BTEXN	Benzene, toluene, ethylbenzene, xylenes, and naphthalene
c	Cancer
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
COC	Contaminant of concern
COPC	Contaminant of potential concern
CPT	Cone penetration testing
DCE	Dichloroethene
DERP	Defense Environmental Restoration Program
DERR	Division of Environmental Response and Remediation
DoD	Department of Defense
DODM	Department of Defense Manual
ECLR	Excess Lifetime Carcinogenic Risk
EPA	U.S. Environmental Protection Agency
EPC	Exposure point concentration
ERPIMS	Environmental Resources Program Information Management System
FS	Feasibility study
ft	Feet (foot)
ft/day	Feet per day
HEAST	Health Effects Assessment Summary Tables
HI	Hazard index
IC	Institutional control
IRIS	Integrated Risk Information System
ISCO	In situ chemical oxidation

JBSA	Joint Base San Antonio
LNAPL	Light non-aqueous phase liquid
LUST	Leaking underground storage tank
MCL	Maximum Contaminant Level
mg/kg	Milligram(s) per kilogram
mg/L	Milligram(s) per liter
MNA	Monitored natural attenuation
MTBE	Methyl tertiary butyl ether
NA	Not applicable
nc	Non-cancer
NCP	National Oil and Hazardous Substances Pollution Contingency Act
NE	Not established
O&M	Operation and maintenance
OO-ALC/JA	Office of the Staff Judge Advocate Directorate
OU	Operable Unit
OWS	Oil-water separator
PCE	Tetrachloroethene
POTW	Publicly owned treatment works
ppbv	parts per billion by volume
RAO	Remedial action objective
RBSL-C	Carcinogenic Risk-Based Screening Level
RBSL-NC	Non-carcinogenic Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
redox	Reduction/oxidation
RG	Remediation goal
RI	Remedial investigation
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SI	Site Inspection
SVE	Soil vapor extraction
TBA	Tertiary butyl alcohol
TCE	Trichloroethene
TMV	Toxicity, mobility, or volume
TPH	Total petroleum hydrocarbons
UAC	Utah Administrative Code
UDEQ	Utah Department of Environmental Quality
USAF	U.S. Air Force
UST	Underground storage tank
VOC	Volatile organic compound

# Declaration for the Record of Decision

---

## Site Name and Location

Operable Unit (OU) 11  
Hill Air Force Base  
Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)  
Identification Number UT0571724350  
Davis County, Utah

## Statement of Basis and Purpose

This Record of Decision (ROD) presents the selected remedy for OU 11 at Hill Air Force Base (AFB), Utah (Figure 1-1). OU 11 is also identified as Installation Restoration Program Site OT097. The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986; and the National Oil and Hazardous Substances Pollution Contingency Act. Information supporting the decisions concerning the selected remedy is contained in the Administrative Record for this site.

This document is issued by the U.S. Air Force (USAF), who is the lead agency for cleanup actions at Hill AFB and by the U.S. Environmental Protection Agency (EPA) who is the lead regulatory agency for CERCLA response actions at Hill AFB. This document was compiled and evaluated by the Air Force Civil Engineer Center/Environmental Operations Midwest Region Branch (AFCEC/CZOM). The USAF signatory for this document will be the 75<sup>th</sup> Air Base Wing Commander at Hill AFB.

The USAF and EPA jointly select the remedy at Hill AFB. The State of Utah concurs with the selected remedy.

## Assessment of the Site

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

## Description of Selected Remedy

The selected remedy for OU 11 is part of a Basewide effort to clean up contaminated soil, surface water, and groundwater. At Hill AFB, there are 15 OUs, all of which are in different stages of investigation or cleanup. OU 11 is a groundwater OU located in the southern portion of Hill AFB. OU 11 contains the site of a former Base gas station that was renovated into an auto repair facility in the early 1980s. Between 1957 and 1980, the site contained underground storage tanks containing gasoline and waste oil. The auto repair building also contained four maintenance bays and an oil-water separator (OWS). The primary contaminants at OU 11 are light non-aqueous phase liquid (LNAPL); trichloroethene; benzene, toluene, ethylbenzene, xylenes, and naphthalene; and methyl tertiary butyl ether. The contaminants associated with OU 11 are contained on-Base in subsurface media and do not extend to off-Base areas.

The selected remedy addresses LNAPL and contaminated groundwater at OU 11 and includes the following components:

## LNAPL

- Soil vapor extraction (SVE)
- Manual recovery of LNAPL in wells
- Performance monitoring
- Institutional controls (ICs).

## Groundwater

- Groundwater extraction and treatment
- Monitored natural attenuation (MNA)
- Performance monitoring
- ICs.

ICs include both land and groundwater use restrictions placed on the OU 11 area. The purpose of the ICs is to prevent contact with contaminated media until cleanup goals have been met. All activities that have the potential to disturb contaminated soil or groundwater or interfere with remedial action equipment and facilities are prohibited without the concurrence of the Air Force Civil Engineer Center Environmental Directorate (AFCEC CZ) and the Air Force Legal Operations Agency, Environmental Law and Litigations Division (AFLOA/JACE) .

In addition, all projects requiring a Base Civil Engineer Work Order Request Form (Air Force Form 332) are reviewed and approved by AFCEC/CZOM prior to any work starting. Further, in accordance with the Defense Environmental Restoration Program Manual (Department of Defense Manual 4715.20USAF), the USAF is required to include an IC to address future on-Base indoor air exposures in the event that construction is considered near the OU 11 area before all site cleanup goals have been met.

The selected remedy for OU 11 addresses potential risk posed by the site by minimizing or preventing direct contact with contaminated media through implementation of ICs. Further, the selected remedy includes active contaminant mass removal through SVE, manual LNAPL recovery, and extraction and treatment of groundwater. The selected remedy also includes monitored natural attenuation. The LNAPL present at OU 11 constitutes a principal threat waste. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur. The source area at OU 11 is the area of the former underground storage tanks and OWS and the current LNAPL area. The remaining contamination present at OU 11 is considered non-principal threat wastes, which, according to the EPA, are those source materials that generally can be reliably contained and would present a low risk in the event of exposure. Although contaminated groundwater is present in the source area, it is not categorized as source material.

## Statutory Determinations

The selected remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and uses permanent solutions and alternative treatment technologies to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy to reduce the toxicity, mobility, or volume of hazardous substances.

Because this remedy will result in hazardous substances remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

## Data Certification Checklist

The following information is included in Sections 1 through 9 of this ROD:

- Contaminants of concern (COCs) and their respective concentrations (Sections 2 and 3)
- Baseline risk represented by the COCs (Section 4)
- Cleanup levels established for COCs and the basis for these levels (Section 5)
- How source materials constituting principal threats are addressed (Section 7.3)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the risk assessment and ROD (Section 3.4)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 8)
- Estimated capital; annual operation and maintenance; and total present worth costs, discount rate, and number of years over which the remedy costs are projected (Table 6-1)
- Key factors that led to selecting the remedy (Section 7).

Additional information for OU 11 can be found in the Administrative Record.

## Authorizing Signatures and Support Agency Acceptance of Remedy

Authorizing and support agency signatures are included on the following pages.

**THIS PAGE INTENTIONALLY LEFT BLANK**

**U.S. ENVIRONMENTAL PROTECTION AGENCY**



7/21/15

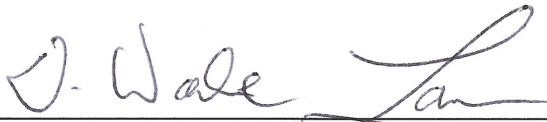
Martin Hestmark  
Assistant Regional Administrator  
Office of Ecosystems Protection and Remediation  
U.S. Environmental Protection Agency Region 8

Date

**THIS PAGE INTENTIONALLY LEFT BLANK**



**AIR FORCE MATERIEL COMMAND  
HILL AIR FORCE BASE, UTAH**



D. WADE LAWRENCE, Colonel, USAF  
Vice Commander, 75th Air Base Wing

11 Aug 2015  
Date

**THIS PAGE INTENTIONALLY LEFT BLANK**

**UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY**

  
\_\_\_\_\_  
Alan Matheson  
Executive Director  
Utah Department of Environmental Quality

*AUG 4, 2015*  
\_\_\_\_\_  
Date

**THIS PAGE INTENTIONALLY LEFT BLANK**

# 1.0 Site Name, Location, and Description

---

Hill Air Force Base (AFB) is located in northern Utah, approximately 25 miles north of Salt Lake City and 5 miles south of Ogden. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number for Hill AFB is UT0571724350. The Base occupies approximately 6,700 acres in Davis and Weber counties (Figure 1-1). The Base is bounded to the north by the Davis-Weber Canal, a privately owned irrigation canal, and to the east by private property. Interstate 15 and State Route 193 form the western and southern boundaries of the Base, respectively. Since 1920, the property currently comprising Hill AFB has been used in service of the Nation's defense. Operations have included munitions storage; manufacturing; and repairing, testing, and maintenance of aircraft and other weapon systems.

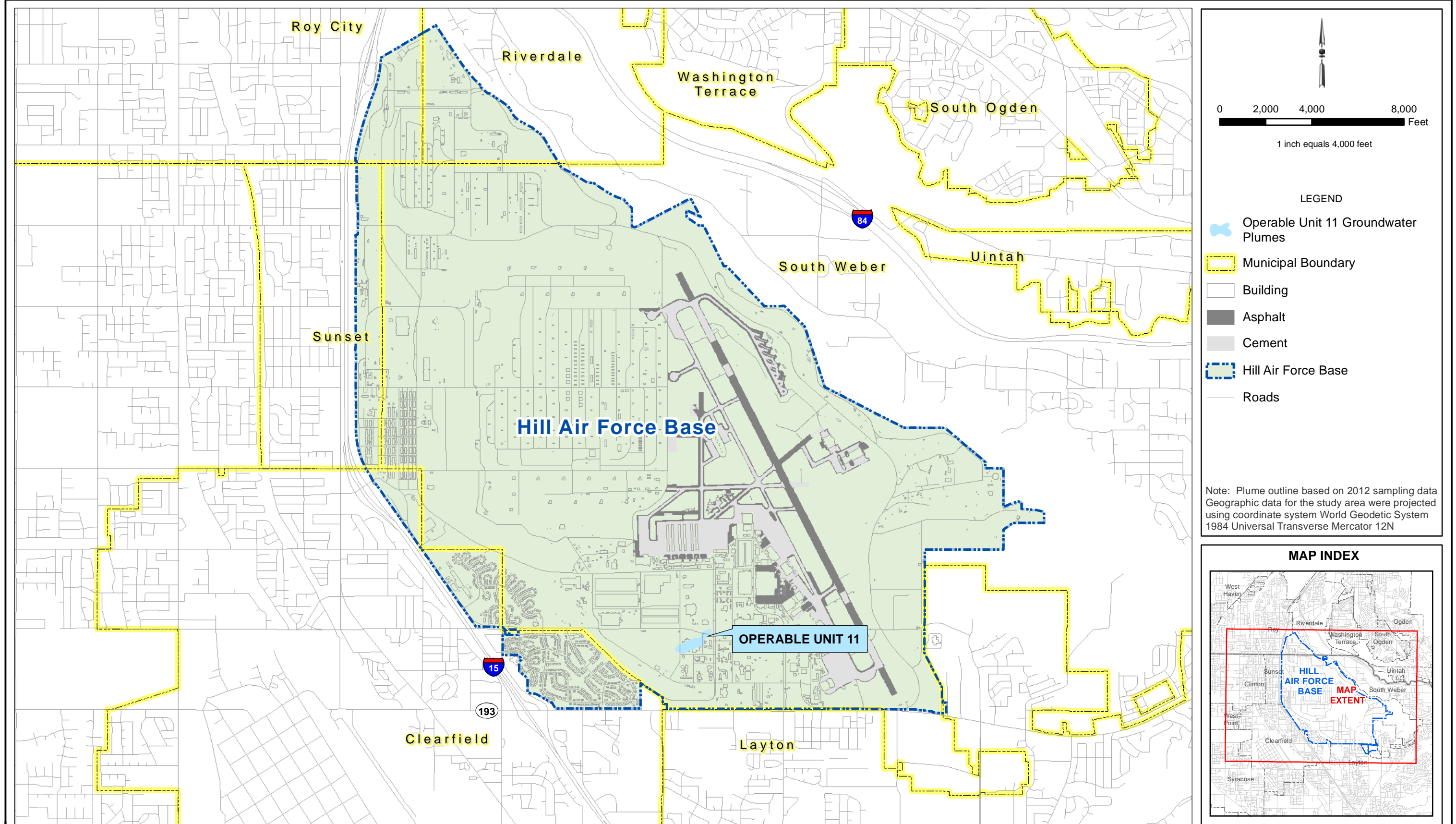
Operable Unit (OU) 11, located in the southern part of Hill AFB (Figure 1-1), is one of 15 OUs at Hill AFB that have been investigated to determine the nature and extent of contamination. OU 11 is located entirely on-Base and consists of a source area and a dissolved-phase groundwater plume, both of which are associated with a former on-Base fueling station that was renovated into an auto repair facility (Building 454) in the 1980s. Between 1957 and 1980, the site contained two 10,000-gallon underground storage tanks (USTs) and a 500-gallon UST for the storage of waste oil. The original pump island was located south of Building 454. A third 10,000-gallon UST was installed during renovations in 1980, and three new pump islands were added to the facility. Building 454 also contained four maintenance bays and an oil-water separator (OWS) likely connected to floor drains in the bays. The contaminants at OU 11 are likely related to releases from leaking tanks or during fuel handling, as well as releases of products and chemicals used at the vehicle maintenance facility. Site features are presented in Figure 1-2.

The Building 454 USTs and associated piping were removed in 1995, and three new gasoline USTs were installed in a different location north of Building 454 (a fourth was installed in 2000). Building 454 and the north pump island were demolished in 1999, and the new Hill AFB Autopride Service Station (Building 420) was constructed.

Fuel-related contaminants at OU 11 were first discovered during an investigation in 1993. Trichloroethene (TCE) was discovered in the site groundwater during a separate 1996 investigation. In May 1999, light non-aqueous phase liquid (LNAPL) was discovered during installation of a groundwater monitoring well. The remedial investigation (RI) was conducted to evaluate the nature and extent of the contamination discovered during these initial investigations. The primary contaminants found at OU 11 are LNAPL and volatile organic compounds (VOCs) including TCE; benzene, toluene, ethylbenzene, xylenes, and naphthalene (BTEXN); and methyl tertiary butyl ether (MTBE) (CH2M HILL 2005). The current extent of the groundwater plumes is presented in Figure 1-3.

The BTEXN and MTBE plumes have historically been associated with UST Site 454 and managed under the Utah Department of Environmental Quality (UDEQ) Division of Environmental Response and Remediation (DERR) Leaking Underground Storage Tank (LUST) Program. Soil and LNAPL contamination were also historically managed under the UDEQ-DERR LUST Program and have been remediated as part of the Hill AFB UST Program. However, the chlorinated solvent plume, which has been identified at the site, is regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). If a solvent plume merges with a petroleum hydrocarbon plume, the resulting mixed plume can be addressed under CERCLA.

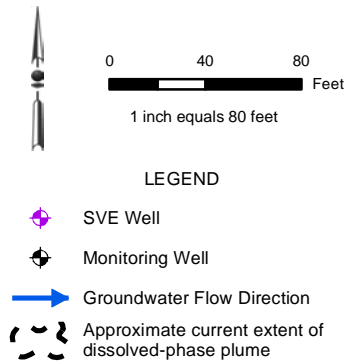
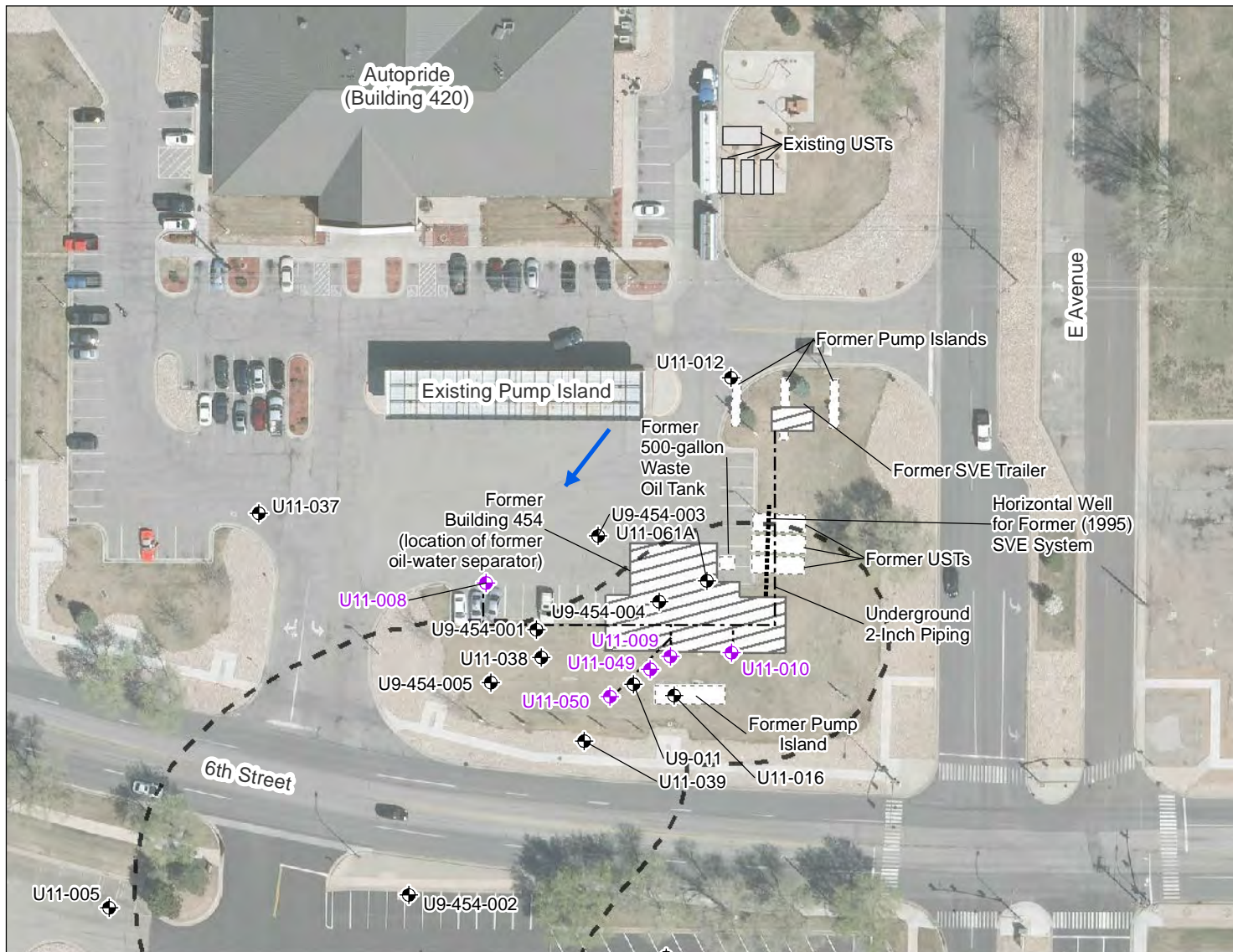
As a result, both UDEQ-DERR and CERCLA requirements must be satisfied during cleanup. Due to the presence of chlorinated solvents in the shallow groundwater, UDEQ-DERR has agreed to consolidate planning and reporting required for UST and CERCLA sites, allowing for an integrated remedial approach presented in this Record of Decision (ROD).



**FIGURE 1-1**  
**SITE LOCATION MAP**  
OPERABLE UNIT 11 RECORD OF DECISION  
HILL AIR FORCE BASE, UTAH

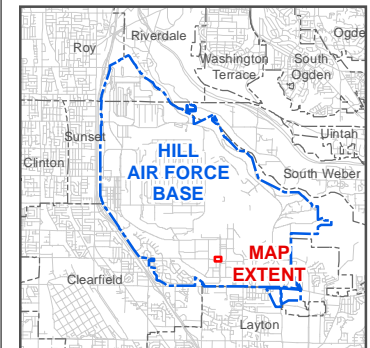
THIS PAGE INTENTIONALLY LEFT BLANK





**Notes:**  
 SVE - Soil Vapor Extraction  
 UST - Underground Storage Tank  
 Aerial Photo: Utah AGRC 2012  
 Plume extent based on the results of groundwater samples collected during November-December 2012.  
 Geographic data for the study area were projected using coordinate system World Geodetic System 1984 Universal Transverse Mercator 12N

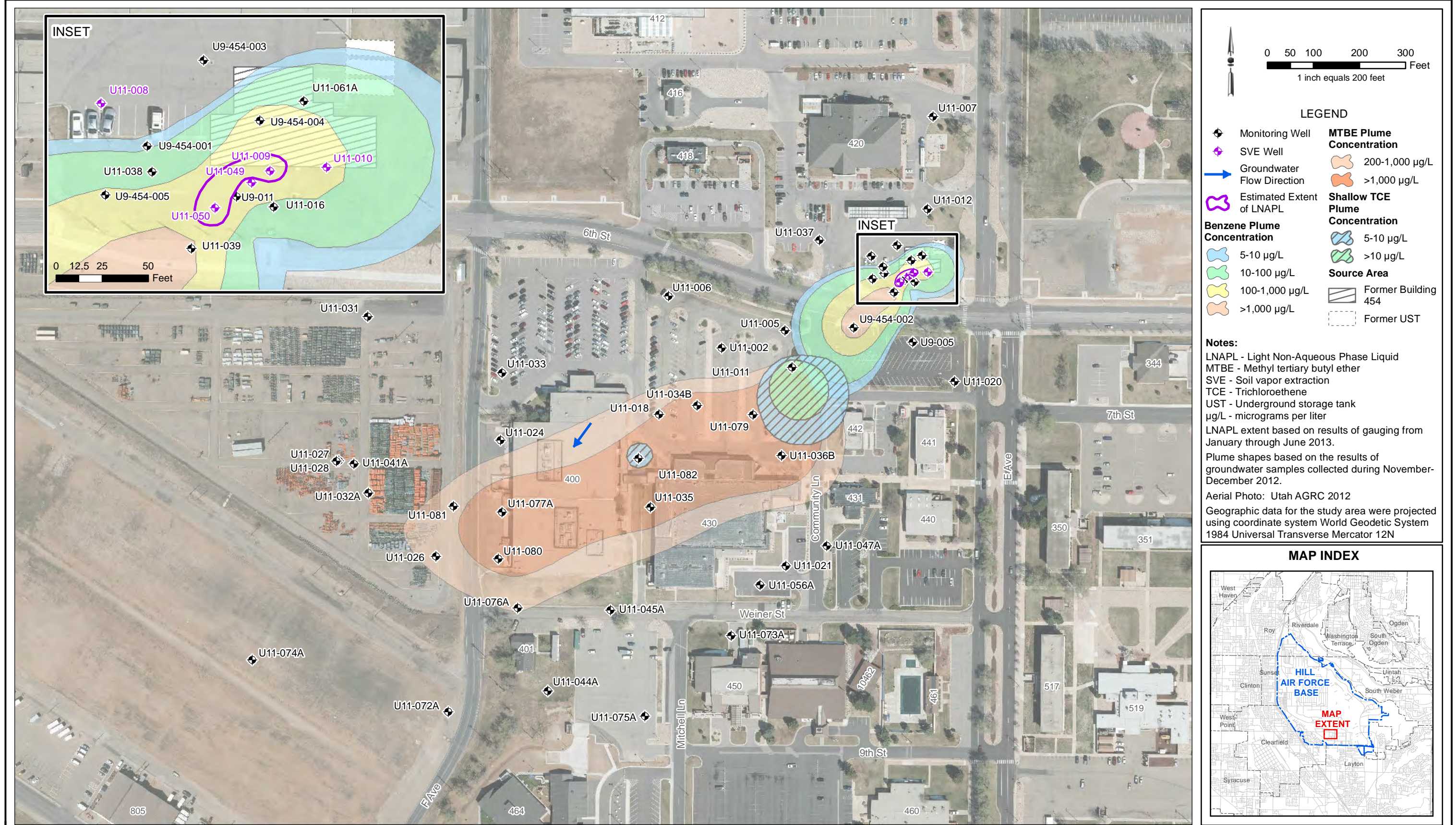
#### MAP INDEX



**FIGURE 1-2  
 SITE FEATURES**  
 OPERABLE UNIT 11 RECORD OF DECISION  
 HILL AIR FORCE BASE, UTAH

**THIS PAGE INTENTIONALLY LEFT BLANK**





**FIGURE 1-3**  
**GROUNDWATER PLUMES**  
OPERABLE UNIT 11 RECORD OF DECISION  
HILL AIR FORCE BASE, UTAH



THIS PAGE INTENTIONALLY LEFT BLANK

## 2.0 Site History and Enforcement Activities

---

### 2.1 History of Site Activities

#### 2.1.1 History of Hill Air Force Base

Hill AFB has been the site of military activities since 1920, including distribution of military equipment, aircraft rehabilitation and maintenance, and missile assembly. In 1920, the Ogden Arsenal was established in the western part of Hill AFB as part of the Army Reserve Depot. The Arsenal comprised approximately 3,300 acres and several buildings and storage magazines that were used to store ordnance. Activities at the Arsenal continued into World War II and included loading explosives into 100- to 2,000-pound bombs, artillery shells, and small arms munitions. The Ogden Arsenal also manufactured ammunition and became a distribution center for motorized equipment, artillery, and general ordnance. In 1945, manufacturing operations ceased and the Arsenal was used for storage and distribution of vehicles, artillery, small arms, parts, and supplies. In 1941, the Ogden Air Depot began operations as a maintenance and aircraft rehabilitation facility for a variety of aircraft. In 1948, the Ogden Air Depot was renamed Hill AFB. In 1955, the Ogden Arsenal was transferred from the U.S. Army Reserve to the U.S. Air Force (USAF). This transfer approximately doubled the size of Hill AFB and added about 600 buildings and structures to the Base.

A variety of ongoing industrial operations support the missions of Hill AFB, including metal plating, degreasing, paint stripping, painting, sanding, and other operations associated with aircraft, missile, and vehicle repair and maintenance. These industrial operations have generated numerous spent chemicals and wastes, including chlorinated and non-chlorinated solvents and degreasers, petroleum hydrocarbons, acids, bases, metals, and other chemicals. These chemicals and their associated waste products were historically disposed at the Industrial Wastewater Treatment Plant, chemical disposal pits, or landfills on the Base or at other USAF facilities. The Environmental Restoration Management Action Plan (Select Engineering Services 2012) presents a summary of the historical operations conducted at Hill AFB and wastes associated with those activities. Hazardous wastes currently generated at Hill AFB are managed (i.e., stored, treated, and disposed) according to the requirements of the Resource Conservation and Recovery Act (RCRA) of 1976 and applicable State of Utah laws.

#### 2.1.2 CERCLA Regulatory History

As far back as the 1970s, the USAF has made compliance with applicable environmental regulations a priority in its operations at Hill AFB. Since 1984, the USAF has committed significant resources to assess and remediate environmental contamination identified at Hill AFB. CERCLA established a national program for responding to releases of hazardous substances into the environment. In anticipation of CERCLA, the Department of Defense (DoD) developed the Installation Restoration Program to respond to releases of toxic or hazardous substances at DoD facilities. Hill AFB was already engaged in the Installation Restoration Program when it was placed on the CERCLA National Priorities List in July of 1987.

The Superfund Amendments and Reauthorization Act (SARA), enacted in 1986, requires that federal facilities follow the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In addition, the program requires greater involvement and oversight of the U.S. Environmental Protection Agency (EPA) for federal facility cleanups. The Installation Restoration Program follows these requirements. In response to SARA, the EPA developed the Guidance for Conducting Remedial

Investigations and Feasibility Studies under CERCLA (EPA 1988). This document was used as guidance for preparing the RI and feasibility study (FS) reports for OU 11. A Guide for Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents (EPA 1999) was used as guidance in preparing the Proposed Plan for OU 11 and this ROD.

### 2.1.3 Federal Facility Agreement

The USAF has conducted most of its environmental restoration activities at Hill AFB under the Federal Facility Agreement that was signed in April 1991 by the USAF, EPA Region 8, and UDEQ. The purpose of the agreement was to establish a framework and schedule for developing, implementing, and monitoring appropriate remedial actions at Hill AFB. The Federal Facility Agreement was signed pursuant to numerous authorities under relevant regulatory jurisdictions, including, but not limited to, CERCLA, RCRA, NCP, the Clean Water Act, and the Defense Environmental Restoration Program (DERP). Additional regulatory history and current regulatory framework details can be found in the Environmental Restoration Management Action Plan (Select Engineering Services 2012).

## 2.2 Description and History of Operable Unit 11

### 2.2.1 History of the Operable Unit 11 Area

OU 11 contains the site of a former Base gas station that was renovated into an auto repair facility in the early 1980s. Between 1957 and 1980, the site contained two 10,000-gallon gasoline USTs and one 500-gallon waste oil UST. The original pump island was located south of the building. The building also contained four maintenance bays and an OWS. As part of the renovation in 1980, a third 10,000-gallon gasoline UST and three new pump islands were added to the facility.

In August 1995, the four USTs and associated piping were removed and three new gasoline USTs (two 10,000-gallon and one 12,000-gallon) were installed in a new location north of Building 454. Building 454 and the north pump island were demolished in Winter 1999, and the new Hill AFB Autopride Service Station (Building 420) was constructed. New pump islands were placed south of Building 420. In August 2000, a fourth 10,000-gallon gasoline UST was installed adjacent to the other USTs to meet the station's demand. Former and current site features are presented in Figure 1-2.

In May 1999, LNAPL was discovered in the groundwater during the installation of Monitoring Well U9-454-001 (Figure 1-2). The monitoring well is located downgradient from the former building. Groundwater was observed at approximately 39 feet (ft) below ground surface (bgs).

Since Spring 2001, groundwater contamination at OU 11 has been investigated under CERCLA. Groundwater monitoring wells have been installed to characterize and delineate the nature and extent of groundwater contamination at the site. The OU 11 RI Report and subsequent groundwater monitoring reports document the activities performed during the OU 11 investigation and summarize previous investigations in detail (CH2M HILL 2005, 2007, and 2008a).

The MTBE, BTEXN, and shallow TCE contaminant plumes reside in the upper portion (above approximately 130 ft bgs) of the shallow aquifer and have been associated with the OU 11 sources (USTs and OWS). The primary contaminants used for monitoring plume migration and stability in groundwater at OU 11 include TCE, benzene, and MTBE in the upper portion of the shallow aquifer. A deep TCE plume was detected underlying OU 11 in 2007 during an investigation into the vertical and horizontal extent of the MTBE contamination. This deep TCE plume is located at a depth of approximately

180-300 ft bgs. The investigations performed to date at OU 11 indicate that the origin of the deep TCE plume is upgradient of the OU 11 site and is part of the OU 8 plume. Because the deep TCE plume does not originate from the OU 11 source area, the OU 11 ROD does not include alternatives for remediation of the deep TCE groundwater contamination.

As discussed previously, OU 11 includes subsurface contamination consisting of a localized area of LNAPL and an area of dissolved-phase groundwater contamination with chlorinated solvents (TCE) and other VOCs, including BTEXN and MTBE. The BTEXN and MTBE plumes have historically been associated with UST Site 454 and managed under the UDEQ-DERR LUST Program. Soil and LNAPL contamination was also historically managed under the UDEQ-DERR LUST Program and has been remediated as part of the Hill AFB UST Program (note that the LNAPL is associated with a petroleum release and is not considered a hazardous waste under RCRA). However, the chlorinated solvent plume, which has been identified at the site, is regulated under CERCLA. As a result, both UDEQ-DERR and CERCLA requirements must be satisfied during cleanup. Due to the presence of chlorinated solvents in the shallow aquifer, the UDEQ-DERR has agreed to consolidate planning and reporting required for UST and CERCLA sites, allowing for an integrated remedial approach presented in this ROD. Although reporting has been combined for the state-regulated and CERCLA contaminants, the requirements of both programs must be satisfied for the applicable contaminants. That is, actions for contamination associated with the former gasoline USTs (LNAPL, BTEXN, and MTBE) must meet UDEQ requirements and actions for the chlorinated solvent plume must comply with CERCLA.

## 2.2.2 Source Areas

Source area investigations for OU 11 were performed beginning in the mid-1990s as part of the South Area Site Inspection (SI) for OU 9 and the UST Program. The source of the fuel-related groundwater contamination at OU 11 was the LUSTs for gasoline that were removed and replaced in 1995 (Figure 1-2). An OWS was located at the former Building 454 and is a likely source for the chlorinated solvent contamination at the site. Other than the activities associated with the USTs and former Building 454, no other source of groundwater contamination has been identified at the site.

## 2.3 Investigation History of Operable Unit 11

### 2.3.1 Underground Storage Tank Site 454 Investigations

In 1993, the USAF initiated a series of subsurface investigations at several UST locations that included Site 454. Analytical results for the samples collected at Site 454 (samples collected in the immediate vicinity of the building and former UST locations shown on Figure 1-2) revealed the presence of fuel-related contaminants, consisting predominantly of gasoline, in the soil to depths of 15 ft bgs. Additional soil samples collected between 23 and 25 ft bgs in the same boreholes contained total petroleum hydrocarbons (TPH) concentrations near or below the detection limit of 10 milligrams per kilogram (mg/kg), indicating a limit to the vertical extent of contamination. Groundwater samples were not collected.

Confirmation soil samples were collected in Fall 1995 following the removal of the original tanks. Analytical results indicated a single detection of benzene and multiple detections of toluene, ethylbenzene, and xylenes. Several of the samples also had notable detections of TPH in both diesel and gasoline ranges (Dames and Moore, Inc. 1996).

Building 454 was further investigated in 1996 as part of a separate CERCLA investigation associated with the OU 9 South Area SI (CH2M HILL 2001a). The building area was investigated to evaluate the

potential for soil and groundwater contamination associated with an OWS located in the center of the building that received drainage from the four maintenance bays. Results from the OU 9 SI indicated contamination in the soil and in the perched groundwater, specifically TPH and benzene exceeding industrial risk-based screening levels in soil and benzene, toluene, and TPH gasoline range organics exceeding risk-based screening levels and/or Maximum Contaminant Levels (MCLs) in groundwater. Three monitoring wells (U9-005, U9-007, and U9-011; locations shown on Figure 2-1) were installed in 1996 downgradient of soil contamination areas, and TCE was detected in Monitoring Well U9-005 at a concentration of 3.8 micrograms per liter ( $\mu\text{g/L}$ ). The detection of chlorinated compounds in groundwater triggered further investigation under the OU 9 RI. Results from the South Area SI are documented in the Comprehensive Data Evaluation for the South Area of OU 9 SI (CH2M HILL 2001a).

In September 1998, cone penetration testing (CPT) and direct-push groundwater sampling were performed at three locations in an additional investigation to evaluate site stratigraphy and to collect VOC samples from the perched groundwater system underlying the site. VOCs (toluene and xylenes) were detected at low levels below  $1.5 \mu\text{g/L}$  in two of the samples. Five piezometers (U9-454-605 through -609) were installed in 1999 around Building 454 to monitor groundwater levels (Figure 2-1). One monitoring well (U9-454-001 [Figure 1-2]), was installed downgradient of the former building in May 1999. LNAPL was observed in this monitoring point.

During Summer 2000, CPT and direct-push groundwater sampling was performed at 11 locations in the vicinity of the former Building 454 to evaluate the vertical and lateral extent of soil contamination and groundwater impacts in the area. Groundwater samples were analyzed for VOCs. Based on the CPT logs, LNAPL impacts were generally limited to the smear zone where the groundwater undergoes seasonal fluctuations. VOCs including BTEXN, MTBE, and TCE were detected in groundwater samples (CH2M HILL 2005). The nature and extent of VOC contamination in groundwater is discussed in Section 3.2.

An additional piezometer (U9-454-617) was also installed in Summer 2000 (Figure 2-1). Four additional monitoring wells, U9-454-002 through U9-454-005 (Figure 2-1), were installed in September 2000 to further define the extent of the LNAPL plume. Soil samples were not collected from these wells. Organic vapors in the wellhead were measured with a photoionization detector in each of these monitoring wells. Photoionization detector measurements at U9-454-002 were 330 parts per million, and were greater than 10,000 parts per million at the other three monitoring wells. LNAPL was not present in the wells (CH2M HILL 2001b).

In February 2001, the Subsurface Investigation Report for UST Site 454 (CH2M HILL 2001b) was completed. This report concluded that no significant vadose zone contamination was present at the site. It was also recommended that LNAPL recovery from Monitoring Well U9-454-001 continue until no measurable LNAPL is present in the well. LNAPL recovery has been ongoing since November 2000 at UST Site 454 (refer to Section 2.4 for a summary of remedial actions conducted at OU 11).

### 2.3.2 Operable Unit 11 Remedial Investigation

The OU 11 RI Report (CH2M HILL 2005) documents the investigation of groundwater contamination beneath the area of UST Site 454 that is managed under CERCLA. CPT and HydroPunch™ sampling investigation activities were performed at OU 11 between 1993 and 2003 as part of various environmental programs, including the South Area SI (CH2M HILL 2001a), the UST Program, and the OU 11 RI. As part of these programs, a total of 75 CPT points were completed and 118 HydroPunch groundwater samples were collected. Piezometers were installed at some locations to assess groundwater elevations and were abandoned after completion of the RI.



Monitoring wells were installed at OU 11 between 1999 and 2003 in addition to monitoring wells that had previously been installed beginning in 1996 as part of the UST Site 454 investigations (Figure 2-1). The objective of the monitoring well installation program was to help define the LNAPL plume at the former Building 454, define the nature and extent of groundwater contamination at OU 11, and develop a groundwater monitoring well network. The locations of monitoring wells were chosen based on the occurrence of groundwater contamination observed in direct-push groundwater samples and the groundwater flow directions developed from potentiometric maps.

Slug tests were performed at 12 wells in 2002-2003 to assess in situ aquifer permeability. Of the 12 wells tested, 8 were screened in the upper portion of the shallow aquifer above 100 ft bgs where the groundwater plumes associated with OU 11 reside (U11-002, U11-004, U11-006, U11-011, U11-012, U11-023, U11-029, and U9-454-002) and the measured hydraulic conductivity ranged from 0.15 to 6.0 feet per day (ft/day) with a mean of 1.7 ft/day.

Soil samples were collected at selected depths during installation of the monitoring wells. The soil samples were analyzed for VOCs and TPH using EPA Methods SW8260B and 418.1, respectively. Petroleum hydrocarbon VOCs were detected, including BTEXN and MTBE. The maximum soil concentrations were detected in the sample collected from Monitoring Well U11-008 in the source area (Figure 2-1) at the 35-37 ft bgs depth interval, including benzene at 125,600 micrograms per kilogram ( $\mu\text{g/kg}$ ), toluene at 829,900  $\mu\text{g/kg}$ , ethylbenzene at 167,600  $\mu\text{g/kg}$ , total xylenes at 1,019,400  $\mu\text{g/kg}$ , and TPH at a concentration of 3,430 mg/kg. MTBE and TCE were not detected in the soil samples collected from monitoring well borings (CH2M HILL 2005). Physical tests were conducted on soil samples to more definitively characterize soils and develop criteria for contaminant transport assessments. The test methods included total organic carbon, cation exchange capacity, moisture content, bulk density, dry density, Atterberg limits, grain size analysis (sieve and hydrometer), and vertical permeability.

### 2.3.3 Soil Gas Investigation

Following the RI, a soil gas investigation was conducted in May and June 2009 to assess the concentrations of contaminants present in soil gas in the OU 11 source area and the areas above the OU 11 groundwater plumes. While the previous site investigations had delineated the extent of groundwater impacts, the soil gas investigation was conducted to assess the potential for vapor intrusion as a result of the OU 11 contamination. TCE was detected at trace concentrations (less than 1 part per billion by volume [ppbv]) only near the OU 11 source area, and MTBE was not detected in soil gas. The BTEXN constituents were detected at less than 20 ppbv. No spatial correlation between shallow soil gas contaminant concentrations and concentrations was apparent in the dissolved groundwater plumes.

Tetrachloroethene (PCE) was also analyzed in the soil gas samples, although it is not considered a contaminant of concern (COC) at OU 11 (refer to Section 4.0 for further discussion of COCs). PCE was detected in 8 of 10 soil gas samples at concentrations ranging from 0.2 to 46 ppbv. The highest observed concentrations were near the OU 11 source area. PCE has been detected only sporadically and at low levels below laboratory reporting limits in recent groundwater samples collected from source area monitoring wells. Therefore, groundwater is not a likely source of the PCE detected in soil gas. Residual vadose zone soil contamination is a more likely source.

In summary, the soil gas investigation found that the dissolved groundwater plumes have no demonstrated impact on shallow soil gas (CH2M HILL 2011). Residual soil contamination within the source area is creating soil gas impacts; however, the selected remedy will mitigate these impacts. Consistent with the

DERP Manual, Department of Defense Manual (DODM) 4715.20, evaluation and mitigation of future vapor intrusion risk is required before any future construction at OU 11.

## 2.4 Remedial Actions

Based on the recommendations in the Draft Subsurface Investigation Report and Corrective Action Plan for Building 454, LUST Site EIHG (Dames and Moore, Inc. 1996), a soil vapor extraction (SVE) system was installed in December 1995 to remediate the area where the closure soil samples had been collected. Five soil vapor probes and one horizontal SVE well (Figure 1-2) were installed in the area of greatest contamination north of Building 454 and west of the UST site. The SVE well, installed at 10.5 ft bgs and extending horizontally 43 ft north of the building (horizontal well installed perpendicular to the north side of Building 454, as shown in Figure 1-2), remained in operation until Spring 1998. Closure was verified by the collection of soil samples that indicated all contaminants were below the UST closure criteria (CH2M HILL 2005).

The primary focus of the remediation strategy for the source area has been to address LNAPL, which is the source of vadose zone contamination. Manual LNAPL removal was initiated in October 2000, and consists of using either passive LNAPL skimmers or bailers to remove LNAPL from wells where the measured thickness is greater than 1 inch. Since 2000, approximately 235 gallons of LNAPL has been manually removed. Manual recovery via bailing from wells containing LNAPL is ongoing.

A corrective action plan (CH2M HILL 2002) was submitted and approved by the UDEQ in August 2002. After a 30-day public comment period, the 2002 Corrective Action Plan was approved, and an SVE system (Figure 1-2) was installed in September 2002 for the purpose of remediating LNAPL.

Operation of the SVE system was initiated in September 2002 for the purpose of removing LNAPL and enhancing natural biodegradation. Initially, the SVE system was connected to a single monitoring well (U11-009). By March 2004, a second (U11-010) and third well (U11-008) had been added in an effort to increase LNAPL recovery. The SVE system was shut down in November 2006 to perform a rebound test (to assess whether contaminant concentrations would increase when the system was turned off) and to reevaluate its configuration. It was restarted in September 2007 with two additional extraction points (U11-049 and U11-050), but was shut down in 2008 due to the submergence of the well screens below the water table. Locations of SVE wells are presented in Figure 2-1. The water table at the site has risen primarily due to variability in the weather and precipitation amounts. Some of the water level rise may also be attributed to watering of turf near the source area. Currently, the SVE system is not operating and the extraction equipment has been demobilized from the site.

Throughout the life of the SVE system, emission gas samples were collected on a quarterly basis (at a minimum) for air quality monitoring and to estimate the amount of TPH removed by volatilization. VOC concentrations in the emission gas were below the regulated discharge limit of 2 pounds per day for benzene; therefore, the emissions were released without additional treatment. It is estimated that 5,200 gallons of TPH has been removed by SVE volatilization from the LNAPL and impacted soils in the source area. The rate of TPH removal was greatest during the first few years of SVE operation and began to level off by 2006. The amount of TPH removed by natural biodegradation has not been estimated; however, SVE generally enhances biodegradation by increasing the flow of oxygen in the vadose zone (Suthersan 1999).

## 2.5 Highlights of Community Participation

The USAF followed a remedy selection process in accordance with the public participation requirements of CERCLA Sections 113(k)(2)(B)(i-iv) and 117. Additional requirements as outlined in the Hill AFB Environmental Restoration Community Relations Plan (Hill AFB 1997) were also fulfilled. The USAF meets quarterly with members of the Hill AFB Restoration Advisory Board. The Restoration Advisory Board for Hill AFB consists of approximately 25 people representing the local communities; federal, state, county, and city governments; local sewer and water districts; civic, business, and environmental groups; the USAF, and other interested parties. Restoration Advisory Board meetings are advertised in local newspapers and open to the public. Community concerns are solicited and addressed prior to making a final proposal. However, under CERCLA Sections 104 and 120, the NCP, and Executive Order 12580, the USAF holds the ultimate responsibility for making decisions regarding the cleanup, with approval from the EPA and concurrence from the State.

Upon completion of the RI/FS process, the USAF delivered the RI and FS documents to federal and state agencies and the Administrative Record repositories. These Administrative Record repositories are located at Hill AFB; at Weber State University in the Stewart Library on the main campus in Ogden, Utah; and in the Davis Campus Library in Layton, Utah. The Administrative Record file and the information repositories are open to the public.

The Proposed Plan for OU 11 was presented to the public for comment in March 2014. The notice of availability of the Proposed Plan was published in the Ogden Standard Examiner. The public comment period ran from 25 March to 23 April 2014. An open house format public meeting was held on 9 April 2014 at The Landing (Club Hill) at Hill AFB, Utah. Public comments on the Proposed Plan for OU 11 are discussed in the responsiveness summary in Section 9.0.

## 2.6 Scope and Role of the Operable Unit 11 Response Action

Response actions at Hill AFB are structured into 15 OUs. Most of the OUs are geographically defined, though some are delineated on the basis of contaminated media. Remedial actions are addressed separately for each OU, and each OU is at different stages of investigation or remediation.

This ROD addresses LNAPL and associated smear zone and groundwater contamination at OU 11. Soil data presented in the OU 11 RI (CH2M HILL 2005) show that soil concentrations above the screening levels are located at a depth greater than 31 ft bgs. In general, these depths are within the LNAPL smear zone created by fluctuations in the water table elevation and the VOCs detected in soil are related to the LNAPL (i.e., BTEXN compounds were detected) and are, therefore, attributed to residual LNAPL in the soil and not residual soil contamination.

A soil gas investigation found that the residual LNAPL in the source area is impacting the soil gas; however, there are currently no buildings within 100 ft and, therefore, no vapor intrusion concerns (Figure 2-1) (CH2M HILL 2011). Although not specifically evaluated as part of the risk assessment, potential soil gas impacts will be mitigated by the selected remedy. Additionally, consistent with the DERP Manual, DODM 4715.20, an institutional control (IC) is required for evaluation and mitigation of future vapor intrusion risk before any construction at OU 11.

As described in Section 2.4, various remedial actions have been implemented in the past for contamination associated with UST Site 454. The selected remedy for OU 11 builds upon prior response actions of periodic LNAPL removal and SVE in the source area with the addition of groundwater

extraction and treatment and monitored natural attenuation for the dissolved phase contamination. As discussed in Section 1.0, this ROD presents an integrated remedial approach for the UST and CERCLA sites that comprise OU 11. The scope of the OU 11 response action addresses LNAPL and groundwater contamination as follows:

### **LNAPL**

- SVE
- Manual recovery of LNAPL in wells
- Performance monitoring
- ICs.

### **Groundwater**

- Groundwater extraction and treatment
- Monitored natural attenuation (MNA)
- Performance monitoring
- ICs.



FIGURE 2-1

**SOIL VAPOR EXTRACTION AND MONITORING WELL LOCATIONS**  
OPERABLE UNIT 11 RECORD OF DECISION  
HILL AIR FORCE BASE, UTAH

**THIS PAGE INTENTIONALLY LEFT BLANK**

## 3.0 Site Characteristics

---

### 3.1 Physical Setting

Hill AFB is located in northern Davis County with a small portion of the Base extending into southern Weber County. This region is referred to as the East Shore Area (Feth et al. 1966). The East Shore Area is used to describe a geographic region bounded on the west by the Great Salt Lake and the east by the Wasatch Mountain Range. The East Shore Area is an area extending 40 miles north to south and 3-20 miles east to west in Davis and Weber counties.

#### 3.1.1 Physiography

The East Shore Area is located in the Lake Bonneville Basin of the Basin and Range physiographic province. The Basin and Range physiographic province is characterized by alternating north-south trending fault-bounded mountain ranges flanked by alluvial fan deposits and intermountain basins. The East Shore Area is separated from the Wasatch Mountain Range section of the Middle Rocky Mountain physiographic province by the Wasatch Fault. The Wasatch Fault is located approximately 4 miles to the east of Hill AFB.

#### 3.1.2 Topography

Hill AFB is located between the Great Salt Lake and the Wasatch Mountains. The Great Salt Lake is located 12 miles to the west of Hill AFB at an elevation of 4,200 ft above mean sea level, while the Wasatch Mountains are located approximately 4 miles to the east of Hill AFB. The Wasatch Mountains reach elevations over 9,500 ft above mean sea level in this area. Hill AFB occupies 6,700 acres of the Paleo-Weber River Delta, a terrace approximately 300 ft above the present day Weber River Valley located immediately north of Hill AFB. The terrace slopes from approximately 5,045 ft above mean sea level along the eastern boundary to 4,600-4,800 ft above mean sea level along the western and southern boundaries of Hill AFB. The elevation of OU 11 ranges from approximately 4,720 to 4,770 ft above mean sea level.

#### 3.1.3 Geology

The sediments underlying OU 11 can be generalized into two stratigraphic units, the Provo Formation and Alpine Formation. The Provo Formation consists of fine- to coarse-grained, unconsolidated sand deposits with occasional gravels. The Provo Formation, the shallower of the two formations, was deposited in a near-shore, shallow water environment during a lower stand of ancient Lake Bonneville. At OU 11, the unit consists of gravel, sand, and silty sand deposits (Figure 3-1). The Provo Formation is approximately 25 ft thick near the OU 11 source zone and gradually increases in thickness up to 80 ft near the leading edge of the currently inferred MTBE plume. The Alpine Formation is predominantly composed of unconsolidated and interbedded fine sand, silt, and clay deposits. The interbedded geology sequence of the Alpine Formation varies in thickness from less than 1 inch up to 130 ft thick and is composed of alternating sand, silt, and clay laid down in a varved- or cyclothemic-type sequence. Within the interbedded geologic unit, boreholes occasionally intercepted a thicker lens of sand or silt/clay. These sand or silt/clay lenses are located within the interbedded portion of the Alpine Formation at depths less than 180 ft bgs. The overall thicknesses of these sand or silt/clay lenses vary from 1 to 20 ft.



At a depth greater than approximately 180 ft bgs, a massively bedded sand was discovered that varies in thickness from 20 to 80 ft, occasionally broken by lenses of interbedded lithology. Below the massive sand unit is a lean, dark grayish-brown, silty clay, identifiable by black organic laminations. This silty clay appears to be fairly continuous across the site with a thickness of at least 12 ft. The total thickness has not been established because the boreholes have not been advanced through this silty clay zone. The Provo and Alpine formations are presumed to be approximately 560 ft thick, as logged at Base Supply Well Number 5, located approximately 2,500 ft west of the OU 11 source zone.

### 3.1.4 Hydrogeology

The three principal aquifers that underlie the Hill AFB base area are, from shallowest to deepest, (1) shallow aquifer system, (2) Sunset Aquifer, and (3) Delta Aquifer. In general, shallow aquifers underlying Hill AFB consist of thin water-bearing zones located in the Provo and Alpine formations. The Sunset and Delta aquifers are considered the principal aquifer systems of the Weber Delta Subdistrict and supply many of the local municipalities with culinary water. The Sunset Aquifer is reported to occur from approximately 400 to 550 ft bgs and ranges in thickness from 50 to 250 ft. The majority of wells in the Weber Delta Subdistrict produce groundwater from the deeper Delta Aquifer at depths ranging from 650 to 1,000 ft (Plantz et al. 1986). Few wells penetrate the total thickness of the aquifer, so the total thickness is unknown in many areas.

Existing water quality data from Feth et al. (1966), Plantz et al. (1986), and UDEQ records indicate that the Sunset and Delta aquifers are considered Class IA (pristine) groundwater in accordance with Utah Administrative Code (UAC) R317-6-3. Water quality data for the shallow water-bearing zone indicate that it has more variable water quality than the Sunset or Delta aquifers. The shallow groundwater at OU 11 is currently not classified and not used as a drinking water source. However, based on the State of Utah Groundwater Classes, shallow groundwater like the groundwater at OU 11 could be classified as Class II groundwater in the absence of contamination. Class II groundwater is considered drinking water quality and suitable for consumption (UDEQ 2013). Based on EPA guidelines for groundwater classification (EPA 1986), OU 11 is considered a potential future drinking water source.

Depth to shallow groundwater in the OU 11 area generally ranges from 36 to 40 ft bgs. Shallow groundwater elevations fluctuate based on changes in season, precipitation trends, and local landscape-watering practices. The overlying Provo Formation near OU 11 is for the most part unsaturated, with groundwater predominantly located in the Alpine Formation. The shallow groundwater observed at the site is recharged locally from infiltrating landscape irrigation water and precipitation. The hydrogeology underlying OU 11 consists of shallow unconfined and semi-confined aquifer conditions. Note that the contamination associated with OU 11 resides in the upper portion of the shallow aquifer at depths of approximately 130 ft bgs or less.

Groundwater elevations from shallow monitoring wells in the OU 11 area were assessed. Figure 3-2 shows the potentiometric surface of the upper portion of the shallow aquifer with groundwater flow toward the southwest.

## 3.2 Nature and Extent of Contamination

Site investigations for OU 11 were performed beginning in the mid-1990s as part of the South Area SI for OU 9 and as part of the UST Program. An RI and subsequent soil gas investigation have also been conducted. Previous site investigations are discussed in Section 2.3. The source of the fuel-related groundwater contamination at OU 11 was the LUSTs that were removed and replaced in 1995. An OWS was located at the former Building 454 and is a likely source of the chlorinated solvent contamination at



the site. Other than the activities associated with the USTs and former Building 454, no other source of groundwater contamination has been identified at the site. Soil and groundwater have been investigated at OU 11 to assess the nature and extent of contamination across the site. A summary of site contamination for OU 11 is presented on Figure 3-1.

### 3.2.1 Soil Contamination

Soil contamination observed at OU 11 was limited to the general area of the former USTs, associated fuel piping, and the OWS. Analytical data collected as part of the South Area SI (CH2M HILL 2001a) show that soil concentrations above the screening levels are located at a depth greater than 31 ft bgs. In general, these depths are within the LNAPL smear zone created by fluctuations in the water table elevation and the VOCs detected in soil are related to the LNAPL (i.e., BTEXN compounds were detected) and are, therefore, attributed to residual LNAPL in the soil.

A soil gas survey was conducted in May and June of 2009 with the primary purpose of evaluating soil gas impacts in the source area and the potential for soil gas resulting from the dissolved MTBE, BTEXN, and TCE groundwater plumes at OU 11. TCE was detected at trace concentrations (less than 1 ppbv) only near the OU 11 source area, and MTBE was not detected in soil gas. PCE was detected up to 46 ppbv, and the source of the PCE detections in soil gas did not appear to be associated with groundwater impacts. The BTEXN constituents were detected at less than 20 ppbv. There was no apparent spatial correlation between shallow soil gas contaminant concentrations and concentrations in the dissolved groundwater plumes. Thus, outside the OU 11 source area, the dissolved MTBE, BTEXN, and TCE groundwater plumes were having no demonstrated impact on shallow soil gas (CH2M HILL 2011). Consistent with the DERP Manual, DODM 4715.20, an IC for OU 11 is required for evaluation and mitigation of future vapor intrusion risk before any future construction at OU 11.

### 3.2.2 Light Non-Aqueous Phase Liquid

An LNAPL plume exists slightly downgradient of the former Building 454 USTs. Currently, only Monitoring Well U11-009 is consistently within the LNAPL plume; U11-050 also frequently contains LNAPL. The estimated current extent of LNAPL is shown in Figure 3-3. LNAPL samples were collected from Monitoring Well U11-009 in 2006 and 2009 and were submitted for laboratory analysis of VOCs. Consistent with a gasoline release, the predominant VOCs detected were BTEX compounds (CH2M HILL 2011).

In 2002, the amount of LNAPL remaining at the site was estimated to have a spatial extent of approximately 19,000 square ft and a volume of approximately 500 gallons (CH2M HILL 2002). Observations of LNAPL since 2002 and the startup of the SVE system indicate a decrease in the overall areal extent of LNAPL (CH2M HILL 2008b). In the OU 11 FS Report, the estimated volume of LNAPL remaining after operation of the SVE system was estimated to be less than 200 gallons (total mobile and immobile phases). Figure 3-3 presents the estimated spatial extent (approximately 830 square ft) of the residual LNAPL based on measurements collected in June 2013. LNAPL thicknesses in Monitoring Wells U11-009 and U11-050 during 2013 were less than 0.5 ft.

### 3.2.3 Dissolved Plumes

A total of 23 constituents were identified in the RI as possible COCs for groundwater (Section 4.0). Over the history of the OU 11 site investigations, the plume maps have been contoured using benzene, MTBE, and TCE as indicator contaminants. These indicator contaminants are used to define spatial extent and to

track and identify plume size, orientation, and movement. The contaminants are distributed in the upper portion (up to approximately 130 ft bgs) of the shallow aquifer.

The BTEXN plume, defined by the concentrations of benzene greater than 5 µg/L, has migrated approximately 300 ft to the southwest from the LNAPL source area (Figure 3-3). The plume has not migrated vertically beyond the sand of the upper portion of the shallow aquifer (approximately 130 ft bgs). The LNAPL appears to be a continuing source for the majority of the BTEXN constituents. During the Fall 2012 sampling event, the highest concentration of benzene detected was 5,000 µg/L in Monitoring Wells U9-454-002 and U11-039, screened from 38 to 48 and from 32 to 47 ft bgs, respectively. In general, the highest concentrations of benzene were detected in monitoring wells between 2000 and 2002. The maximum concentration was 30,000 µg/L detected in Monitoring Well U9-454-002 in September 2000. Since this time, benzene concentrations in monitoring wells have been steady or declining. Currently, maximum concentrations of the remaining BTEXN components observed at OU 11 are as follows: toluene at 8,500 µg/L, ethylbenzene at 1,200 µg/L, xylenes at 6,600 µg/L, and naphthalene at 210 µg/L.

In September 2000, the maximum MTBE concentration of 170,000 µg/L was observed at U9-454-002, screened at a depth of 38-48 ft bgs. Presently, the highest measured concentration of MTBE is 8,800 µg/L, detected in Monitoring Well U11-036B, which is screened at a depth of 88.5-91.5 ft bgs. As defined by the 200-µg/L contour (UDEQ-DERR UST Tier 1 screening level), the MTBE plume has migrated approximately 1,200 ft southwest of the source zone (Figure 3-4).

Most of the monitoring wells near the source zone have exhibited a decline in the observed MTBE concentrations, while concentrations have increased in downgradient wells (e.g., U11-011, U11-026, U11-028, U11-032A, and U11-047A). The distribution and trends of the MTBE concentrations, declining in the source zone and increasing in the central and distal portions of the plume, suggest a single pulse release of MTBE with downgradient migration of the plume. Vertical migration of the MTBE plume has also been observed, with downward migration of MTBE in the downgradient portion of the plume. The plume is located within the upper portion of the shallow aquifer, with vertical migration to approximately 130 ft bgs apparent at the downgradient edge of the plume.

In addition to the observed MTBE plume pulling away from the source zone, LNAPL sampling was conducted in January 2009 to investigate whether the LNAPL could be a continuing source of MTBE groundwater contamination. MTBE was not detected in the LNAPL sample. In combination with decreasing MTBE concentrations near the source zone, it appears that the LNAPL is not a continuing source of MTBE.

TCE originating from OU 11 is identified in the shallow interbedded stratigraphic unit, and the plume extent is presented in Figure 3-3. The shallow TCE plume is located at depths from approximately 36 to 130 ft bgs. Currently, the highest concentration of shallow TCE is detected in Monitoring Well U11-011 (screened from 80 to 90 ft bgs), at a concentration of 57 µg/L. The current (as of the Fall 2012 groundwater sampling event) maximum concentration of cis-1,2-dichloroethene (DCE) in OU 11 groundwater is 20 µg/L. Vinyl chloride was not detected in the Fall 2012 sampling event. The shallow TCE plume has migrated approximately 750 ft southwest of the source area and reached a depth of approximately 130 ft bgs. The shallow TCE plume boundaries have remained relatively stable over time, with a general decline in concentrations at most monitoring wells, which suggests that there is no significant continuing source of TCE. Dense non-aqueous phase liquid was not identified during site investigations or well installations, and its presence is not suspected at OU 11 based on groundwater concentrations of TCE. Based on the stability of the plume extents, decreasing concentrations, and lack of a continuing source of TCE, the plume is no longer suspected to be migrating. Additional evaluation of the plume mass and migration using the Thiessen polygon method is discussed in Section 3.3.2.

## 3.3 Fate and Transport of Contaminants

The fate and transport of the contaminants at OU 11 are controlled by the source characteristics, physical and chemical properties of the contaminants, and site physical characteristics (i.e., site hydrogeology). The initial conceptual site model of the OU 11 groundwater plumes was created as part of the OU 11 RI and has subsequently been updated based on more recent findings and by observations of the COCs (BTEXN, MTBE, and TCE), their persistence and distribution in the aquifer, and aquifer conditions.

### 3.3.1 Contaminant Migration

Contaminant migration at the site is primarily influenced by site stratigraphy and hydraulic gradients. Migration of petroleum and chlorinated compounds occurs primarily through the shallow sand zone and interbedded units. Transport of the contaminants appears to be within the interbedded Alpine Formation. OU 11 contaminant concentrations above their respective MCLs or UDEQ-DERR UST Tier 1 screening levels have not been detected deeper than approximately 135 ft bgs. With the current monitoring well configurations, the BTEXN, MTBE, and shallow TCE plumes are well delineated in the horizontal and vertical directions.

The mapped extent of each of the plumes reflects the lapsed time since the initial release and the migration properties for each of the contaminants. As previously stated, the 200- $\mu\text{g/L}$  concentration boundary of MTBE has migrated approximately 1,200 ft from the source zone, while the 5- $\mu\text{g/L}$  plume boundaries for the shallow TCE and benzene plumes extend approximately 750 and 300 ft, respectively, from the suspected source zone. Because of its higher aqueous solubility and relatively low soil organic carbon-water partitioning coefficient ( $K_{oc}$ ), MTBE has a much larger spatial distribution than the BTEXN compounds.

Advective transport of groundwater contamination in the OU 11 saturated zone is demonstrated by the elongation of the MTBE and TCE plumes in the direction of groundwater flow toward the southwest. The geology of the underlying sediments at OU 11 plays a large role in the transport of the COCs through the subsurface. The distribution and transport of the contaminants is controlled by advection and dispersion primarily through the highly interbedded sand and, to a lesser extent, through silts and clays. The distribution and transport of BTEXN, MTBE, and TCE are greatly affected by the interconnectivity of the sands within the interbedded formation. The interconnectivity of the sands provides pathways and facilitates contaminant migration through the subsurface.

A review of BTEXN concentrations from monitoring wells located along the plume boundary indicates that the BTEXN plume may be receding, while TCE concentrations indicate that the shallow TCE plume boundary is generally stable or receding. A review of MTBE concentrations from monitoring wells in and surrounding the plume suggests that the MTBE plume is expanding toward the southwest.

### 3.3.2 Thiessen Polygon Plume Mass Evaluation

A Thiessen polygon analysis method is applied to estimate plume mass for the dissolved-phase benzene, MTBE, and TCE plumes (Figure 3-5). Thiessen polygon analysis is a technique for quantifying a spatially distributed feature represented by unevenly distributed observation points (Brassel and Reif 1979). The Thiessen polygon method partitions an area of interest into polygons associated with each observation point. Further, the polygons enclose all of the area nearer to each polygon's respective observation point than to any other observation point (Whitney 1929); therefore, the area of a Thiessen polygon comprises a weighting factor applied to the parameter value (i.e., concentration) measured at an observation point (i.e., monitoring well).

The Thiessen polygon method can be applied for evaluation of the dissolved plume contaminant mass and center of mass. The Thiessen polygon network, plume centers of mass, and plume mass trends are presented in Figure 3-5. As shown in Figure 3-5, the mass of the dissolved benzene and TCE plumes is decreasing, while the mass of the MTBE plume has remained stable. Based on the evaluation of the center of mass, minimal migration of the benzene plume has occurred. Downgradient migration has been observed in the past for the TCE plume, although the center of mass location has stabilized in the period between 2010 and 2012. The MTBE plume has exhibited the greatest downgradient migration, although the center of mass location was stable between 2011 and 2012.

### 3.3.3 Natural Attenuation Evaluation

The FS for OU 11 included an evaluation to assess whether there is evidence of natural attenuation at the site, and whether the subsurface conditions are favorable for natural attenuation (CH2M HILL 2011). One of the primary factors influencing contaminant stability is reduction/oxidation (redox) conditions in the aquifer. For example, TCE will tend to break down into cis-1,2-DCE and other degradation products under reducing conditions. The complex site geology of OU 11 appears to have resulted in varied redox conditions. At Monitoring Wells U9-011 and U11-002, the presence of sulfide and ferrous iron in the groundwater suggests reductive conditions, while the concentrations of dissolved oxygen indicate the presence of aerobic processes. It is possible that the interbedded geology of OU 11 creates isolated pockets of groundwater that can vary between aerobic and anaerobic conditions.

Evidence for reductive dechlorination of TCE exists primarily in regions where the BTEXN and TCE plumes are commingled or immediately downgradient. Trace concentrations (i.e., below 0.5 µg/L) of TCE degradation products have been observed, including cis-1,2-DCE in Monitoring Wells U11-002 and U9-005 and vinyl chloride in Monitoring Well U11-036B. Outside of the BTEXN plume, evidence of reductive dechlorination of TCE is rarely observed.

Another mechanism for the natural destruction of TCE is aerobic cometabolism. In aerobic cometabolism, the TCE molecule is mineralized by enzymes that are a by-product of microbial respiration. The enzymes fortuitously degrade the contaminant into carbon dioxide, chloride, carbon monoxide, chlorinated oxides, aldehydes, ethanols, epoxides, and a variety of organic acids (Wiedemeier et al. 1999). Testing at OU 11 has indicated the presence of aerobic cometabolic enzymes at concentrations that are favorable for aerobic metabolism of TCE (Lee 2009). Thus, there is the possibility for TCE to degrade under a wider range of redox conditions, with degradation occurring in both aerobic and anaerobic regions of the plume.

Evidence for the breakdown of MTBE may include the presence of the MTBE degradation products tertiary butyl alcohol (TBA) and acetone in the groundwater at OU 11. At the time that the natural attenuation evaluation was completed for the OU 11 FS (CH2M HILL 2011), concentrations of TBA ranged from the low parts per billion up to 6,580 µg/L, while concentrations of acetone ranged from trace levels to 546 µg/L. However, the presence of TBA does not necessarily confirm that degradation of MTBE is occurring in the aquifer at OU 11. There are several plausible explanations for the sources of the TBA, including that it was directly added to fuel as an oxygenate to enhance octane ratings, that it was included in the MTBE itself, or that it may have been generated from MTBE during sample preservation or laboratory analysis. Thus, the presence of TBA alone does not confirm the degradation of MTBE.

In 2006, 2007, and 2008, groundwater samples from numerous wells were obtained to evaluate the potential for MTBE degradation using compound-specific isotopic analysis (Philp and Kuder 2007). The isotopic analysis focuses on identifying microbial degradation of the contaminant by observing the ratio of isotopic species of carbon, namely carbon-12 and carbon-13. The contaminant molecules composed of

the carbon-12 have weaker carbon bonds and will tend to be preferentially degraded over the carbon-13 contaminant molecules. Thus, where microbes are actively breaking down the contaminant compound, a disproportionate number of the carbon-12 molecules will be degraded, resulting in an enrichment of carbon-13 molecules and an isotopically heavier contaminant sample.

Of the 11 compound-specific isotopic analysis samples obtained in 2006, only 1 sample (U11-019) showed any indication of isotopic enrichment suggesting degradation. However, of the 10 samples obtained in 2007 and 6 samples obtained in 2008, no isotopic enrichment was observed in any of the wells, indicating that either (1) MTBE is not actively being degraded at this time, (2) the degradation process is indifferent to isotopic weights, or (3) the degradation is not sufficiently advanced (in terms of percent of material degraded) to show enrichment.

To help answer the question of biodegradation of MTBE, a Bio-Trap® and stable isotope probe investigation was initiated to demonstrate that the in situ microbial population is capable of MTBE biodegradation. The Bio-Trap is a small, passive sampling tool filled with beads coated with powdered activated carbon. These beads provide a substrate where free-floating microbes can attach onto a surface and colonize to form biofilms allowing for the identification of the microbial communities present in the aquifer. Bio-Trap samplers deployed as part of this study were “baited” with labeled MTBE. The labeling process uses carbon-13, a less abundant carbon isotope, in the labeled MTBE molecule in place of the more abundant carbon-12 isotope. Bacteria can then use the carbon-13 labeled compound as a source of carbon or energy. When the carbon-13 labeled MTBE is used as a carbon source, the carbon-13 becomes incorporated into the phospholipid fatty acids of the microbial cell walls. When the labeled carbon-13 molecule is used for energy, the carbon-13 molecule will become oxidized to carbon-13 dioxide, a process referred to as mineralization. Through the use of a stable isotope probe, the quantities of carbon-13 incorporated into the phospholipid fatty acids of the microbes and into dissolved inorganic carbon can be measured to demonstrate that in situ biodegradation of MTBE is occurring at the site. For this study, a total of three Bio-Traps with the labeled MTBE were deployed into Monitoring Wells U11-024, U11-026, and U11-034B for 46 days.

The results of the Bio-Trap and stable isotope probe MTBE investigation demonstrated that a consortium of bacteria within the in situ microbial population is capable of MTBE biodegradation. However, the data do not support decisions to assess whether microbial biodegradation of MTBE is occurring at a rate sufficient to prevent migration of the MTBE plume, nor are there sufficient data from this limited study to assess the rate of MTBE biodegradation.

In summary, evidence suggests that active microbial degradation of MTBE, BTEXN, and TCE compounds is active at OU 11. The degradation of these compounds is occurring either directly as part of microbial respiration or indirectly via aerobic cometabolism. Evidence for direct microbial respiration is available for the MTBE and BTEXN plumes, while TCE is primarily being degraded via aerobic cometabolism. For MTBE, the primary evidence was obtained from the Bio-Trap and stable isotope probe investigation where microbes are incorporating the labeled carbon-13 MTBE into the phospholipid fatty acids, indicating MTBE was used as a source of carbon. In addition, labeled carbon-13 was observed as carbon dioxide at concentrations greater than background, an indication that MTBE was used as an energy source.

Evidence for the microbial degradation of the BTEXN compounds is observed through the steadily declining concentrations, the depressed oxygen levels in the vicinity of the BTEXN plume, the relatively short length of the BTEXN plume (as compared to the other plumes), and knowledge that BTEXN compounds are readily biodegraded under aerobic and anaerobic conditions.

The primary mechanism of degradation of TCE is aerobic cometabolism with localized areas where reducing conditions allow for reductive dechlorination. The evidence for aerobic cometabolism is based on the presence and density of enzymes capable of degrading TCE. Trace concentrations of TCE daughter products indicate the presence of reductive conditions in portions of the plume in the vicinity or immediately downgradient of the BTEXN plume.

While natural attenuation may be used as a component of the remedial strategy, the current rate of natural attenuation is not rapid enough to support MNA as a stand-alone remedy, and there is evidence that natural attenuation is not occurring uniformly throughout the plume areas. Remedial timeframes for natural attenuation of the groundwater plumes were estimated with a site-specific groundwater model with the following results: 32 years for the MTBE plume, 13 years for the TCE plume, and 12 years for the benzene plume (CH2M HILL 2011).

### 3.3.4 Groundwater Flow and Transport Modeling

A groundwater flow and transport model was developed to support the analysis of alternatives in the OU 11 FS. The complete modeling report is included as an appendix in the FS Report (CH2M HILL 2011). The general objective of the modeling effort was to provide insight into past and future subsurface transport of BTEXN, MTBE, and TCE in OU 11 groundwater. Specific objectives of the modeling effort were to accomplish the following:

- Assess potential benefits of implementing different remedial action alternatives in the future and aid in identifying the most cost-effective alternative
- Integrate the conceptual site model with respect to local hydrostratigraphy, groundwater elevations, distribution of each COC, and estimated subsurface hydraulic characteristics
- Gain insights into past and future COC migration pathways
- Help identify data gaps related to groundwater flow and COC transport.

Results of the model as they pertain to the analysis of remedial alternatives are discussed in Sections 6.0 and 7.0. Under a no action or MNA scenario, the model estimated that the timeframe to achieve cleanup goals would be limited by attenuation of the MTBE plume, which was estimated to require 32 years. The model estimated that attenuation of benzene would require 7-12 years and in general will depend upon when LNAPL is removed from the site. The attenuation timeframe for TCE was estimated to be 13 years.

## 3.4 Current and Potential Future Land and Resources Uses

### 3.4.1 Current Land and Water Use

OU 11 is located within the southern, industrial area of the Base. Buildings within this area are used for various military support operations. Buildings and businesses within the immediate vicinity of OU 11 include the Autopride Service Station, a restaurant, the Base Exchange, the Commissary, and a bank. No residential areas share a common property boundary with the site.

No water supply wells are located in the shallow groundwater where the plumes reside. The shallow groundwater at OU 11 is separated from the drinking water aquifers (Sunset and Delta) by several hundred feet of low permeability soils. The nearest drinking water well to OU 11 is the Base Supply Well Number 5, located approximately 2,200 ft west of the Autopride Service Station. This well was installed in 2001 and is screened in the Delta Aquifer at 970-1,030, 1,145-1,245, and 1,315-1,435 ft bgs. No other drinking water wells are located within a 0.5-mile radius of OU 11. The Clearfield Well Number 2 is located approximately 4,000 ft southwest of the site near the Base boundary and is screened in the Delta Aquifer from 675 to 875 ft bgs.

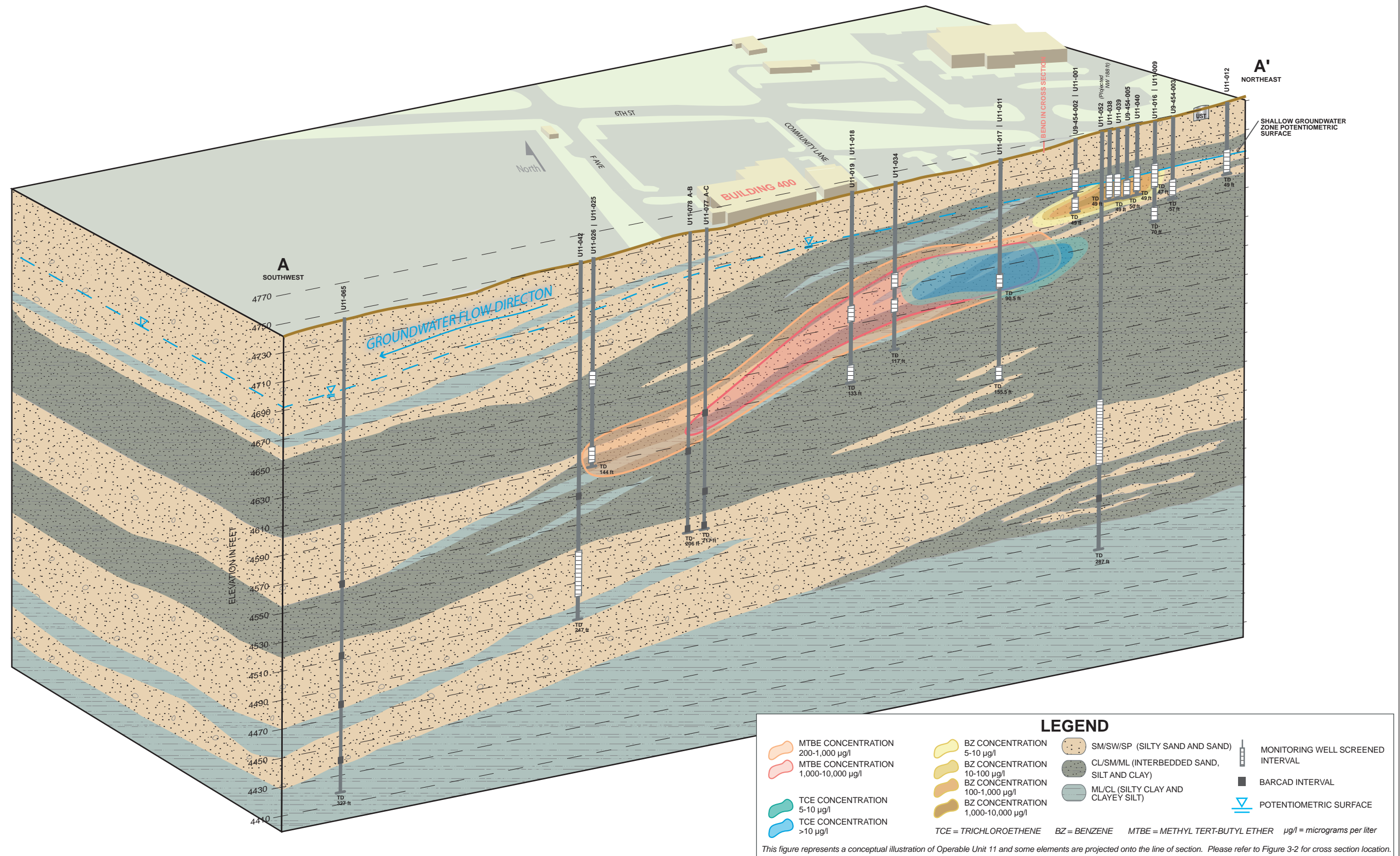
### 3.4.2 Potential Future Land and Water Use

According to the long-term land use plan contained in the Hill AFB General Plan, the planned use of the OU 11 area is continued industrial land use (Hill AFB 2013). However, theoretically, residences could be built in areas overlying contaminated groundwater in the future (either as civilian or military housing), and consequently residents have been retained as a potential (hypothetical) future receptor for the assessment of site risks (Section 4.0).

Based on the State of Utah Groundwater Classes, shallow groundwater like the groundwater at OU 11 could be classified as Class II groundwater in the absence of contamination, although it is not currently classified. Class II groundwater is considered drinking water quality and suitable for consumption (UDEQ 2013). Based on EPA guidelines for groundwater classification (EPA 1986), OU 11 is considered a potential future drinking water source. The shallow groundwater at OU 11 is not currently used as a drinking water source. The shallow groundwater is not expected to be used as a potable water source in the future; however, it could be considered a potential drinking water source in the future based on the EPA and State of Utah classification guidelines.

THIS PAGE INTENTIONALLY LEFT BLANK



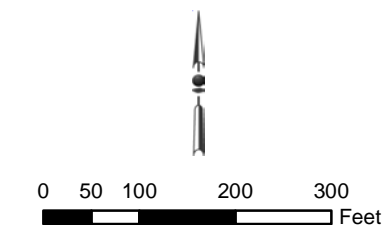
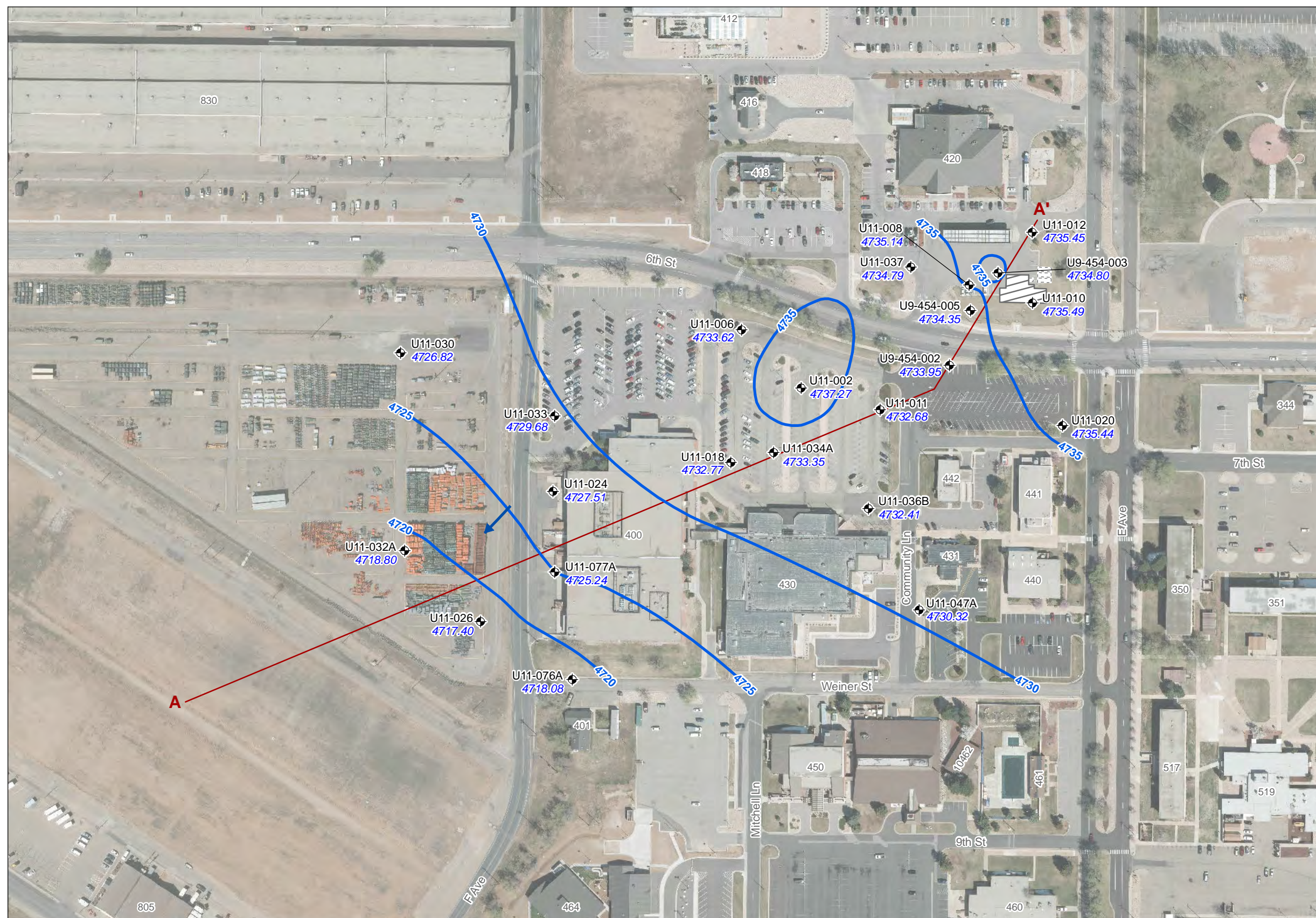


**FIGURE 3-1**  
**CROSS SECTION A-A' WITH MTBE, TCE, AND BENZENE PLUMES**  
 OPERABLE UNIT 11 RECORD OF DECISION  
 HILL AIR FORCE BASE, UTAH



THIS PAGE INTENTIONALLY LEFT BLANK





#### LEGEND

- Shallow Monitoring Well
- Groundwater Isoelevation Contour
- Inferred Groundwater Flow Direction
- Cross Section Line

#### Source Area

- Former Building 454
- Former UST

47XX.XX Groundwater Elevation  
Gauged in Well (ft amsl)

#### Notes:

amsl - above mean sea level  
ft - feet

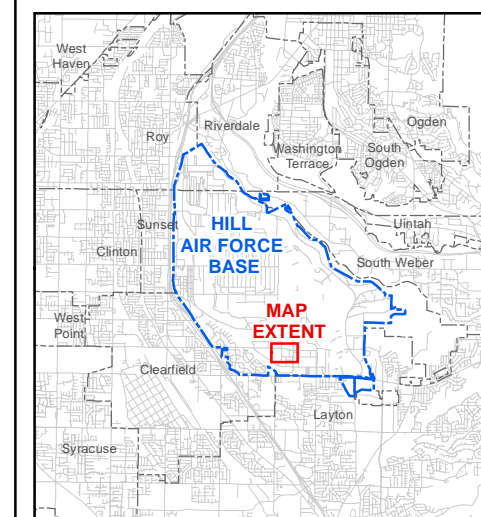
UST - Underground storage tank

Groundwater Elevation Data: CH2M HILL 2011

Aerial Photo: Utah AGRC 2012

Geographic data for the study area were projected using coordinate system World Geodetic System 1984 Universal Transverse Mercator 12N

#### MAP INDEX

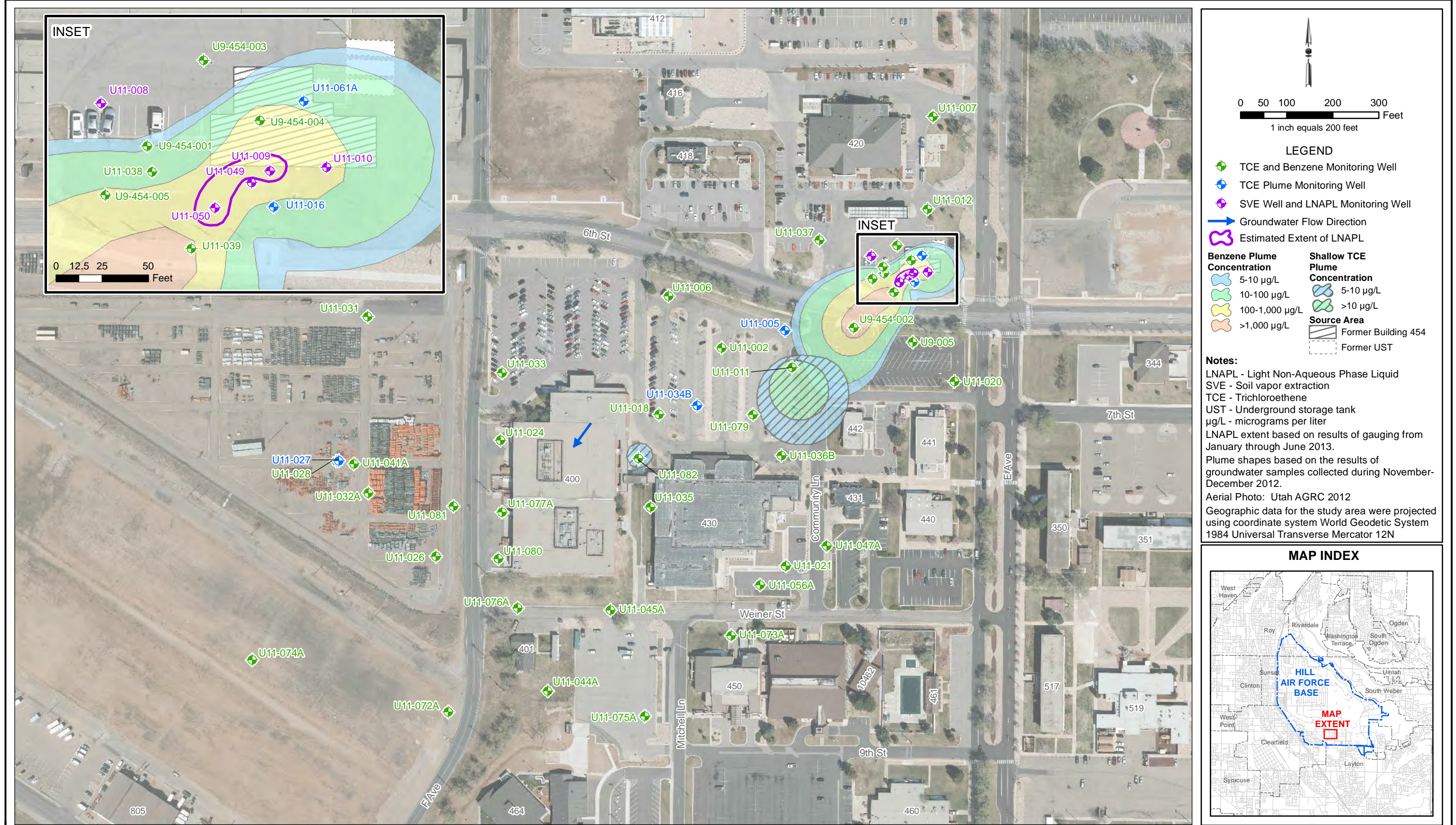


**FIGURE 3-2**  
**POTENTIOMETRIC SURFACE FOR THE SHALLOW AQUIFER AND LOCATION OF CROSS SECTION A-A'**  
OPERABLE UNIT 11 RECORD OF DECISION  
HILL AIR FORCE BASE, UTAH



THIS PAGE INTENTIONALLY LEFT BLANK







THIS PAGE INTENTIONALLY LEFT BLANK







THIS PAGE INTENTIONALLY LEFT BLANK



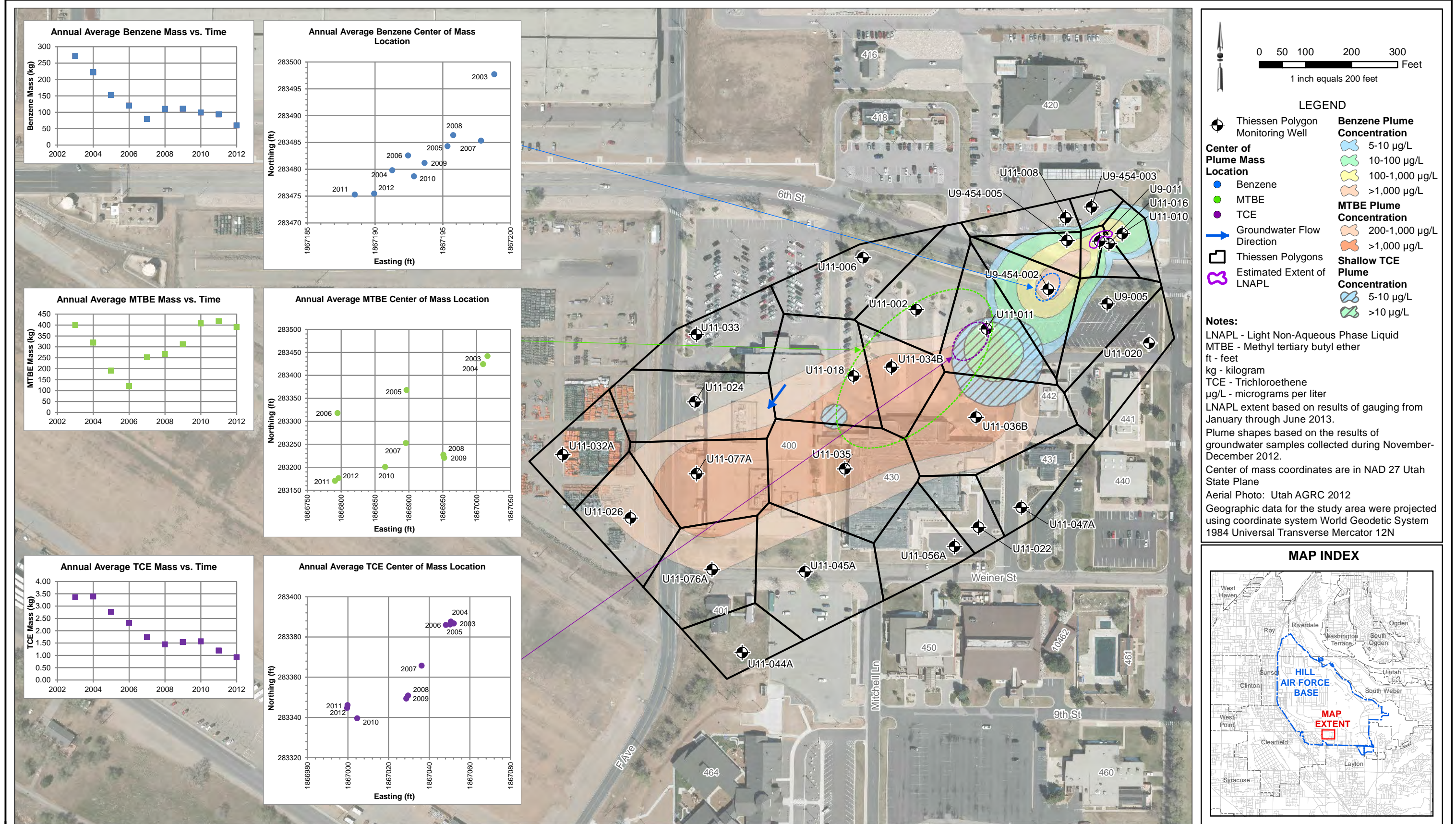


FIGURE 3-5  
THIESSEN POLYGON PLUME MASS ANALYSIS  
OPERABLE UNIT 11 RECORD OF DECISION  
HILL AIR FORCE BASE, UTAH





THIS PAGE INTENTIONALLY LEFT BLANK

## 4.0 Summary of Site Risks

---

The baseline risk assessment estimates potential risk levels if no action were taken at OU 11. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for OU 11.

### 4.1 Human Health Risk Assessment

This section summarizes the results of the risk assessment for OU 11 as documented in the OU 11 RI and FS reports (CH2M HILL 2005 and 2011). The data set for OU 11 has expanded since the OU 11 RI was completed due to installation of new wells and additional groundwater sample results. The OU 11 FS Report included updated information regarding the human health risk assessment completed for the OU 11 RI and found that the results of the original risk assessment were still valid. This summary presents the findings of the RI risk assessment and the updated evaluation presented in the FS.

The steps involved in assessing a potential risk to human health include the following:

- Evaluating the data and selecting contaminants of potential concern (COPCs)
- Identifying complete or potentially complete exposure pathways and characterizing the magnitude of exposure to the COPCs through these pathways
- Assessing the toxicity of the COPCs
- Characterizing the risks.

#### 4.1.1 Identification of Contaminants of Potential Concern

The identification of COPCs is typically performed to reduce the number of constituents to a manageable number, including all the constituents that account for most of the potential risks. Groundwater data collected since 1999, when regular sampling of OU 11 began, were included in the baseline risk assessment. Data for all chemicals including VOCs, semivolatile organic compounds, and metals were considered in the baseline risk assessment. The chemicals detected at or above 5 percent detection frequency were selected as COPCs for the risk assessment. Essential nutrients (e.g., calcium, potassium, and sodium) were excluded from the list of COPCs.

The following subsections discuss the risk assessment process which results in the identification of COCs that drive the need for remedial action. COCs are discussed in Section 4.1.4 and presented in Table 4-1.

#### 4.1.2 Exposure Assessment

The exposure assessment identifies populations (known as receptors) who could come in contact with OU 11 constituents, identifies ways that the contact could occur (known as exposure pathways), and reviews the assumptions used to calculate the amount of contact the receptors could have.

Figure 4-1 presents the conceptual exposure model diagram for OU 11. Potential exposure scenarios are presented in Table 4-1 and are listed as bulleted items that follow.

Under current conditions, receptors with potentially complete pathways for exposure to OU 11 constituents include the following:

- On-Base workers who could inhale constituents volatilized from groundwater to indoor air
- On-Base workers who could inhale constituents volatilized from LNAPL/residual soil contamination to indoor air.<sup>1</sup>

In the future, changes in land use (i.e., a residential land use) could change the pathways by which exposure could occur. The following additional pathways were evaluated in order to provide a conservative benchmark for risk information purposes:

- Hypothetical future residents who could inhale constituents volatilized from groundwater to indoor air
- Hypothetical future residents who could be exposed to groundwater constituents via dermal adsorption or ingestion
- Hypothetical future residents who could inhale constituents volatilized from LNAPL to indoor air.

The risk assessment did not quantify potential risks for outdoor air exposure, including exposure to soil vapor during construction activities. It was assumed that the potential for vapor exposure in outdoor air was minimal compared to the indoor air pathway. Although not specifically evaluated as part of the RI risk assessment, potential soil gas impacts will be mitigated by the selected remedy.

Due to the depth of the soil contamination (in the LNAPL smear zone at the groundwater table as discussed previously), there is no complete exposure pathway for an onsite receptor to contact impacted soil, and no risks were identified for the soil matrix.

### 4.1.3 Toxicity Assessment

Chemicals may have carcinogenic effects as well as non-carcinogenic/systemic effects. Exposure to some of the chemicals detected at OU 11 could potentially result in both types of effects. For carcinogens, it is assumed that any amount of exposure to a carcinogenic chemical poses a potential for generating a carcinogenic response. Non-carcinogenic or systemic effects include a variety of toxicological end points and may include effects on specific organs or systems, such as the kidney, liver, lungs, etc. Threshold

---

<sup>1</sup> Note that LNAPL exposure pathways were not identified/assessed in the RI risk assessment because, at the time that the RI was conducted, soil and LNAPL concerns were being addressed separately from OU 11 groundwater under the UDEQ-DERR LUST Program. This potentially complete pathway was identified after the RI. After the RI, a soil gas investigation found that the residual LNAPL in the source area was impacting the soil gas; however, no buildings are currently located within 100 ft and, therefore, no vapor intrusion concerns exist (CH2M HILL 2011). Although not specifically evaluated as part of the RI risk assessment, potential soil gas impacts will be mitigated by the selected remedy.

levels generally exist for non-carcinogenic effects. No adverse effects are assumed for doses below the threshold level.

Cancer slope factors are used to provide conservative estimates of excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. Slope factors, which are expressed in units of inverse mg/kg per day, are multiplied by the estimated intake of a potential carcinogen expressed in units of mg/kg per day to provide an upper bound estimate of the excess lifetime cancer risk associated with exposure at the intake level. The term “upper bound” reflects the conservative (health protective) estimate of the risks calculated from the slope factors. Use of this approach makes underestimation of the actual cancer risk unlikely. Slope factors are derived from the results of human epidemiological studies or chronic animal bioassays. Slope factors are specific to the route of exposure; for example, oral slope factors are used to evaluate the potential for carcinogenic effects through ingestion of a constituent.

Reference doses are used in evaluating whether there is a potential for adverse health effects, other than cancer, from exposure to OU 11 constituents. Reference doses, which are expressed in units of mg/kg per day, are estimated threshold levels for daily exposure below which exposure is considered safe for humans, including sensitive individuals. Estimated intakes of constituents from environmental media (e.g., the amount of a chemical ingested from contaminated drinking water) can be compared with the reference dose. Reference doses are derived from human epidemiological studies or animal studies to which uncertainty factors have been applied. Like slope factors, reference doses are specific to the route of exposure.

In general, the toxicity values used in the risk assessment were taken from the EPA Integrated Risk Information System (IRIS) electronic database. When toxicity values were not available on IRIS, values were obtained from the EPA Health Effects Assessment Summary Tables (HEAST). Toxicity values from the National Center for Environmental Assessment were used if neither IRIS nor HEAST had oral or inhalation toxicity values. Toxicity values were presented in the OU 11 RI (CH2M HILL 2005). The toxicity values were used to calculate site risks, as described in Section 4.1.4.

#### 4.1.4 Summary of Risk Characterization

Carcinogenic and non-carcinogenic risks were calculated for individual exposure pathways for site constituents and compared with acceptable levels of risk. For each potentially carcinogenic constituent, the probability that an individual will develop cancer over a lifetime as a result of exposure to constituents at OU 11 was estimated from projected intake levels and the cancer slope factor. Cancer risks are probabilities generally expressed in exponential form. An individual excess lifetime risk of  $1 \times 10^{-6}$  indicates that an individual has a 1 in 1 million additional chance of developing cancer as a result of site-related exposure to a carcinogen. The cancer risks were calculated over a 70-year lifetime under exposure conditions specific to OU 11.

In general, the EPA considers excess cancer risks that are below a chance of 1 in 1 million ( $1 \times 10^{-6}$ ) to be so small as to be negligible, while it considers risks above 1 in 10,000 ( $1 \times 10^{-4}$ ) to be sufficiently large that some type of remedial action should be performed. Excess cancer risks in the range between  $1 \times 10^{-4}$  and  $1 \times 10^{-6}$  are considered on a case-by-case basis. In reviewing remedy alternatives, an excess cancer risk below  $1 \times 10^{-6}$  is considered protective, even for sensitive populations.

To characterize the potential non-carcinogenic effects of chemicals, comparisons were made between projected intakes of site constituents and reference doses. A hazard quotient, which is the ratio between exposure point concentration (EPC) of the chemical and that chemical's toxicity value, was calculated for each constituent and exposure pathway. Chemical-specific hazard quotients were then summed for each constituent and each pathway of exposure to calculate the total hazard index (HI) for each exposure

scenario. The HI is not a statistical probability of a health effect occurring. If the exposure level exceeds the appropriate toxicity value (i.e., the hazard quotient is greater than 1), there may be cause for concern. The Superfund site remediation goal for non-carcinogens is a total HI of less than 1.

The OU 11 RI risk assessment identified the following two potential media of concern: groundwater and soil vapor originating from the shallow groundwater. LNAPL exposure pathways were not assessed in the RI risk assessment because at the time that the RI was conducted, soil and LNAPL concerns were being addressed separately from OU 11 groundwater under the UDEQ-DERR LUST Program. Table 4-1 summarizes the results provided in the OU 11 RI risk assessment (CH2M HILL 2005) for the potential exposure pathways and COCs. The risk assessment identified 23 potential COCs based on potential future exposure pathways (Table 4-1). The potential future exposure pathways identified by the risk assessment include direct contact with contaminated groundwater (dermal), ingestion, inhalation from volatilization of contaminated groundwater during household use, and inhalation of vapors originating from the volatilization of contaminated groundwater through a vapor intrusion scenario. Chemical-specific cumulative risks, as calculated in the RI risk assessment, are presented in Table 4-2.

As summarized in Table 4-1, a total of 23 constituents were identified in the RI as possible COCs for groundwater. Over the history of the OU 11 site investigations, the plume maps have been contoured using benzene, MTBE, and TCE as indicator contaminants. These indicator contaminants are used to define spatial extent and to track and identify plume size, orientation, and movement. Detected groundwater contaminant summary statistics using data collected through the Summer 2010 groundwater sampling round were evaluated in the FS and are presented in Table 4-3 as an update to the summary statistics presented in the RI risk assessment. Table 4-3 reports contaminants with a 5 percent or greater detection frequency and, where applicable, the number of samples that are above the UDEQ-DERR UST Tier 1 screening level, the EPA MCL, or the secondary drinking water standard. Tables 4-1 and 4-3 list the same contaminants except for an additional compound (naphthalene) included in Table 4-3. Since naphthalene is below the UDEQ-DERR UST Tier 1 screening level, no change was required in the risk assessment. In addition to the 23 groundwater COCs, the RI risk assessment identified benzene, TCE, and 1,2,3-trichloropropane as possible COCs based on vapor migration from shallow groundwater.

Although the OU 11 RI did not include risk calculations for vapor originating from the LNAPL or from the contaminated soil associated with residual LNAPL, a soil gas investigation was performed prior to the FS (Section 2.3.3). Structures within the vicinity of the former Building 454 USTs are well outside of a 150-ft radius from the soil contamination and LNAPL. EPA guidance recommends that vapor intrusion impacts should be considered for buildings within 100 feet of a potential source of vapor intrusion (EPA 2002). Therefore, due to the distance of the buildings, it is unlikely that vapors from the OU 11 source area impact existing buildings in the vicinity of OU 11.

Due to the depth of the soil contamination (in the LNAPL smear zone at the groundwater table and attributed to residual LNAPL), there is no complete exposure pathway for an onsite receptor to contact impacted soil, and no risks were identified for the soil matrix.

#### 4.1.4.1 Current Risks

The only exposure pathway at OU 11 that is potentially complete as identified by the OU 11 RI is indoor vapor intrusion for on-Base workers. However, based on the results presented in the soil gas survey conducted after completion of the RI (Section 2.3.3), the dissolved BTEXN, TCE, and MTBE groundwater plumes have no demonstrated impact on soil gas in areas outside of the source area. Since no buildings are located in the source area, there is currently no complete exposure pathway for vapor intrusion. Table 4-4 provides a summary of the cumulative human health risks that have been identified in the OU 11 RI and FS.

#### 4.1.4.2 Future Risks

In the future, the hypothetical on-Base resident is a receptor of a potentially complete pathway. Exposure pathways for the resident include both indoor vapor inhalation and direct exposure to groundwater through hypothetical groundwater withdrawal and use in the home. The COCs for vapor inhalation were the same as for the industrial scenario—TCE, benzene, and 1,2,3-trichloropropane. For direct groundwater exposure, the list of COCs is much longer (Table 4-1) but consists primarily of VOCs and includes TCE, BTEXN, and MTBE. The OU 11 RI Report also identified several metals that were present in groundwater at concentrations that exceeded target risk levels (Table 4-2). However, these metals are currently assumed to be naturally occurring, and high concentrations are predominantly associated with sections of the plumes where reducing geochemical conditions preside. While some amount of metals may have become soluble due to the altered natural redox conditions, the zonation of these altered redox conditions is predominantly created by the BTEXN plume. Once beyond the BTEXN plume and within the footprint of the MTBE plume, oxidizing conditions are generally restored, and the soluble metals concentrations return to background concentrations. The ability of technologies to address metals was not considered in the FS screening process for OU 11. VOCs are the primary contributors to the calculated carcinogenic and non-carcinogenic risk (Table 4-2).

Based on the risk assessment and the nature and extent of contaminants at OU 11 (Section 3.3), VOCs are the primary constituents addressed in the remedial alternatives for OU 11. Based on their temporal and spatial prevalence, BTEXN, MTBE, and TCE will be the primary focus for evaluating remedial technologies.

## 4.2 Ecological Risks

Ecological risks at OU 11 were not evaluated because there is limited ecological habitat (the site is primarily paved with grass median areas), and there is no complete pathway for potential ecological receptors to be impacted. Contamination at OU 11 is limited to the subsurface (groundwater and LNAPL at the groundwater table) with which ecological receptors do not have direct contact. Groundwater at OU 11 is encountered at approximately 30-40 ft bgs and has not been observed to emerge as surface water or seeps in the OU 11 area (i.e., there are no surface water discharges associated with the plume).

## 4.3 Uncertainty Analysis

The uncertainty associated with the human health risk assessment is primarily a combination of the uncertainties associated with the site characterization, exposure assessment, and toxicity evaluation. The site is considered to be well characterized, and groundwater monitoring data have been collected for more than a decade. The contaminant nature, extent, and concentration trends have been well established. Therefore, groundwater characterization presents a relatively low uncertainty. There is greater uncertainty associated with constituent concentrations in indoor air. However, the indoor air risk calculations are believed to be conservative, as the vapor intrusion model is designed to be conservative. Further, a depth of 8 ft bgs was assumed for the water table. The depth to groundwater is greater than 25 ft under much of the OU 11 area. Greater depths would have resulted in lower indoor air concentrations and, therefore, lower risks.

The EPCs were calculated using the 95 percent upper confidence limits (or the maximum detected concentration in the event that less than 10 data points existed). Given the relatively large number of data points for the majority of COCs, the 95 percent upper confidence limits are considered representative of

the true mean concentrations in the groundwater plumes. Consequently, there is relatively low uncertainty in the EPCs. Estimates of exposure are based on EPA guidance using conservative assumptions. Therefore, they are more likely to overestimate rather than underestimate exposure.

Uncertainties associated with the toxicity assessment include extrapolations from high to low dose, extrapolations from animals to humans, and lack of some toxicity values. The overall approach of the EPA in deriving toxicity values, as with exposure parameters, is to be conservative such that there is a greater potential to overestimate than underestimate risk. The risks presented in Table 4-2 do not include inhalation risk from constituents without inhalation toxicity values, and consequently inhalation risk may be underestimated. It is generally accepted for the organic constituents that the inhalation toxicity is frequently similar to oral toxicity, and it is an accepted practice to adopt the oral reference dose or cancer slope factor for the inhalation route. Route-to-route extrapolation was used in the baseline risk assessment for some, but not all, chemicals without inhalation toxicity values.

Additional uncertainties pertain to future land use. A primary uncertainty associated with OU 11 is whether the hypothetical future exposure pathways, especially hypothetical residential potable use of groundwater and vapor intrusion pathways, will actually become complete in the future. If not, the actual cancer risks and HIs for these future exposure scenarios are zero. It is expected that the OU 11 area will remain under DoD ownership and will continue to be used for industrial purposes in the future. However, theoretically, residences could be built in areas overlying contaminated groundwater in the future (either as civilian or military housing); consequently, residents have been retained as a potential (hypothetical) future receptor for the assessment of site risks. It should be noted that current EPA risk assessment guidance requires consideration of such pathways. For those exposure scenarios that have been quantitatively evaluated, the risk assessment is expected to be conservative, and the actual risks are expected to be less than those calculated in the baseline risk assessment.

## 4.4 Overview of Site Risks

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Remedial action at OU 11 is warranted on the basis of potential future risks to human health and the environment (i.e., to prevent a significant risk to hypothetical future residents). Also, remedial action is generally warranted when MCLs are exceeded in groundwater. For the hypothetical potable use scenario, the calculated carcinogenic risk is 0.01, or 1 in 100. Furthermore, groundwater contaminants are present in excess of the Safe Drinking Water Act MCLs. Therefore, action is warranted to restore the groundwater to beneficial use (i.e., drinking water) and address source materials (i.e., LNAPL) that are contributing to the exceedance of protective levels in groundwater. The LNAPL is understood to be the source of detections of VOCs in soil within the LNAPL smear zone. Therefore, the soil is not considered a source of groundwater contamination, and no remedial action for soil is warranted; however, the LNAPL, which may act as a source of VOCs in groundwater, is addressed by this ROD. Potential residential groundwater use associated with future hypothetical scenarios accounts for the majority of the risk by ingestion, inhalation, and dermal pathways.



TABLE 4-1  
Remedial Investigation Risk Assessment Summary  
Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Media	Exposure Scenarios	Current/Future	Exposure Pathways Included in Risk Calculations	Complete or Incomplete	Contaminants of Concern and Basis	Comments
Groundwater	Hypothetical On-Base Resident	Future	Direct Ingestion Dermal (bathing) Inhalation (volatilization from indoor water use)	Complete (future only)	1,2,3-Trichloropropane (c) 1,2-Dichloroethane (c,nc) Arsenic (c,nc) Barium (nc) Benzene (c,nc) Bis(2-ethylhexyl)phthalate (c) Cadmium (c) Chloroform (c,nc) Chloromethane (c) cis-1,2-Dichloroethene (nc) Ethylbenzene (c) Iron (nc) Isopropylbenzene (nc) m,p-Xylenes (nc) Manganese (nc) Mercury (nc) MTBE (c,nc) o-Xylene (nc) sec-Butylbenzene (nc) Selenium (nc) Toluene (nc) TCE (c,nc) Xylenes (nc)	
	Construction Worker	Current and Future	--	Incomplete	--	Groundwater at present depths is not likely to be encountered during construction activities
Indoor Air (vapor migration from shallow groundwater)	Hypothetical On-Base Resident	Future	Inhalation	Complete (future only)	1,2,3-Trichloropropane (c) Benzene (c,nc) TCE (c)	
	On-Base Worker	Current and Future	Inhalation	Complete (future only)	1,2,3-Trichloropropane (c) Benzene (c,nc) TCE (c)	
Soil* and LNAPL	Worker and Hypothetical On-Base Resident	Future	Inhalation	Complete (future only)	No current impacts were identified via soil gas sampling. Potential future impacts directly over the source area will be evaluated as necessary for future construction.	
	Construction Worker	Current and Future	--	Incomplete	--	Residual LNAPL contamination at present depths is not likely to be encountered during construction activities

**NOTES:**

c = Cancer.

LNAPL = Light non-aqueous phase liquid.

MTBE = Methyl tertiary butyl ether.

nc = Non-cancer.

OU = Operable Unit.

TCE = Trichloroethene.

\*Soil impacts are within the LNAPL smear zone at the groundwater table and are attributed to residual LNAPL.

**THIS PAGE INTENTIONALLY LEFT BLANK**

TABLE 4-2

## Chemical-Specific Cumulative Risks in Groundwater

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Scenario	Parameter Name	Units	Total Samples	Total Detects	Risk Exceed.	EPC	RBSL-C	Risk ELCR*	Risk ELCR, %	RBSL-NC	Risk HI*	Risk HI, %
Vapor Intrusion in the Work Space – Base Worker	1,2,3-Trichloropropane	µg/L	218	11		6.99E+01	1.66E+01	4.00E-06	36.00%	1.66E+06	4.00E-03	2.20%
	1,2,4-Trimethylbenzene	µg/L	28	9		3.44E+02				1.04E+04	3.00E-02	17.20%
	1,2-Dichlorobenzene	µg/L	223	16		5.00E+01				5.21E+05	1.00E-04	0.00%
	1,2-Dichloroethane	µg/L	221	19		5.87E+01	2.37E+02	2.00E-07	2.10%	1.08E+04	5.00E-03	2.80%
	1,3,5-Trimethylbenzene	µg/L	28	4		2.09E+02				1.02E+04	2.00E-02	10.70%
	2,4-Dimethylphenol	µg/L	18	6		6.14E+00						
	2-Methylnaphthalene	µg/L	19	7		1.70E+01				5.17E+04	3.00E-04	0.20%
	2-Methylphenol	µg/L	18	7		1.47E+01						
	4-Methylphenol	µg/L	18	6		2.38E+01						
	Acetone	µg/L	166	28		1.20E+02				1.15E+06	1.00E-04	0.10%
	Arsenic	µg/L	13	6		2.03E+01						
	Barium	µg/L	13	13		1.83E+03						
	Benzene	µg/L	222	100	21	1.45E+03	3.94E+02	4.00E-06	31.50%	3.50E+04	4.00E-02	21.50%
	Benzoic Acid	µg/L	19	3		2.07E+01						
	Benzyl alcohol	µg/L	19	1		7.98E+00						
	bis(2-Ethylhexyl) Phthalate	µg/L	19	5		3.33E+00						
	Cadmium	µg/L	13	3		3.57E+00						
	Carbon Disulfide	µg/L	194	23		5.14E+01				1.75E+05	3.00E-04	0.20%
	Chloroform	µg/L	222	11		6.80E+01	1.57E+02	4.00E-07	3.70%	3.89E+03	2.00E-02	9.10%
	Chloromethane	µg/L	222	24		1.15E+02	8.91E+02	1.00E-07	1.10%	1.72E+05	7.00E-04	0.30%
	Chromium, Total	µg/L	13	5		8.01E+00						
	cis-1,2-Dichloroethene	µg/L	222	13		7.60E+01				4.81E+04	2.00E-03	0.80%
	Di-n-Butylphthalate	µg/L	19	1		3.76E+00						
	Ethylbenzene	µg/L	222	47		1.41E+02	3.19E+03	4.00E-08	0.40%	1.27E+06	1.00E-04	0.10%
	Iron	µg/L	11	9		1.84E+03						
	Isopropylbenzene	µg/L	27	3		3.51E+02				7.17E+03	5.00E-02	25.40%
	m,p-Xylene	µg/L	197	52		3.47E+02				9.37E+05	4.00E-04	0.20%
	Manganese	µg/L	6	4		6.28E+02						
	Mercury	µg/L	13	9		2.86E-01				7.22E+02	4.00E-04	0.20%
	Methyl Ethyl Ketone	µg/L	211	32		2.32E+02				1.90E+07	1.00E-05	0.00%
	Methyl Isobutyl Ketone	µg/L	222	13		2.19E+02				1.18E+07	2.00E-05	0.00%
	Methyl Tert-Butyl Ether (MTBE)	µg/L	217	91	3	4.59E+03	6.33E+04	7.00E-08	0.60%	6.78E+06	7.00E-04	0.40%
	Naphthalene	µg/L	218	29		7.48E+01				1.09E+04	7.00E-03	3.60%
	Nickel	µg/L	3	3		5.60E+00						
	n-Propylbenzene	µg/L	28	2		1.91E+02				1.77E+05	1.00E-03	0.60%
	o-Xylene (1,2-Dimethyl Benzene)	µg/L	197	39		1.65E+02				9.37E+05	2.00E-04	0.10%
	p-Cymene (p-Isopropyltoluene)	µg/L	28	2		3.47E+02						

TABLE 4-2

## Chemical-Specific Cumulative Risks in Groundwater

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Scenario	Parameter Name	Units	Total Samples	Total Detects	Risk Exceed.	EPC	RBSL-C	Risk ELCR*	Risk ELCR, %	RBSL-NC	Risk HI*	Risk HI, %
	Phenol	µg/L	18	8		3.38E+01						
	Sec-Butylbenzene	µg/L	28	3		3.47E+02				2.19E+06	2.00E-04	0.10%
	Selenium	µg/L	13	3		2.18E+01						
	Toluene	µg/L	221	89		1.86E+03				4.49E+05	4.00E-03	2.10%
	Trichloroethene (TCE)	µg/L	221	62	8	6.16E+01	2.15E+01	3.00E-06	24.50%	3.08E+04	2.00E-03	1.00%
	Xylenes, Total	µg/L	24	15		2.50E+03				9.37E+05	3.00E-03	1.40%
	Zinc	µg/L	13	5		4.85E+01						
<b>Total</b>								1.00E-05	100.00%		2.00E-01	100.00%
Groundwater Exposure – Base Resident	1,2,3-Trichloropropane	µg/L	218	11	11	6.99E+01	3.05E-02	2.00E-03	21.00%	8.42E+01	8.00E-01	0.30%
	1,2,4-Trimethylbenzene	µg/L	28	9	3	3.44E+02				3.77E+02	9.00E-01	0.40%
	1,2-Dichlorobenzene	µg/L	223	16		5.00E+01				8.70E+02	6.00E-02	0.00%
	1,2-Dichloroethane	µg/L	221	19	19	5.87E+01	1.22E-01	5.00E-04	4.40%	4.34E+00	1.00E+01	5.40%
	1,3,5-Trimethylbenzene	µg/L	28	4	1	2.09E+02				4.39E+02	5.00E-01	0.20%
	2,4-Dimethylphenol	µg/L	18	6		6.14E+00				2.74E+02	2.00E-02	0.00%
	2-Methylnaphthalene	µg/L	19	7	4	1.70E+01				2.69E+01	6.00E-01	0.30%
	2-Methylphenol	µg/L	18	7		1.47E+01				7.17E+02	2.00E-02	0.00%
	4-Methylphenol	µg/L	18	6		2.38E+01				7.18E+01	3.00E-01	0.10%
	Acetone	µg/L	166	28	1	1.20E+02				2.60E+02	5.00E-01	0.20%
	Arsenic	µg/L	13	6	6	2.03E+01	7.59E-03	3.00E-03	24.50%	6.17E-01	3.00E+01	13.10%
	Barium	µg/L	13	13	13	1.83E+03				1.44E+02	1.00E+01	5.10%
	Benzene	µg/L	222	100	75	1.45E+03	3.24E-01	4.00E-03	40.90%	1.80E+01	8.00E+01	32.20%
	Benzoic Acid	µg/L	19	3		2.07E+01				5.83E+04	4.00E-04	0.00%
	Benzyl alcohol	µg/L	19	1		7.98E+00				4.58E+03	2.00E-03	0.00%
	bis(2-Ethylhexyl) Phthalate	µg/L	19	5	1	3.33E+00	1.83E+00	2.00E-06	0.00%	1.12E+02	3.00E-02	0.00%
	Cadmium	µg/L	13	3	1	3.57E+00				1.03E+00	3.00E+00	1.40%
	Carbon Disulfide	µg/L	194	23		5.14E+01				4.25E+02	1.00E-01	0.00%
	Chloroform	µg/L	222	11	11	6.80E+01	1.58E-01	4.00E-04	3.90%	2.64E+00	3.00E+01	10.30%
	Chloromethane	µg/L	222	24	2	1.15E+02	1.50E+00	8.00E-05	0.70%	2.69E+02	4.00E-01	0.20%
	Chromium, Total	µg/L	13	5		8.01E+00				3.09E+03	3.00E-03	0.00%
	cis-1,2-Dichloroethene	µg/L	222	13		7.60E+01				2.55E+01	3.00E+00	1.20%
	Di-n-Butylphthalate	µg/L	19	1		3.76E+00				8.55E+02	4.00E-03	0.00%
	Ethylbenzene	µg/L	222	47	26	1.41E+02	2.68E+00	5.00E-05	0.50%	4.73E+02	3.00E-01	0.10%
	Iron	µg/L	11	9	6	1.84E+03				6.17E+02	3.00E+00	1.20%
	Isopropylbenzene	µg/L	27	3		3.51E+02				2.35E+02	1.00E+00	0.60%
	m,p-Xylene	µg/L	197	52	34	3.47E+02				8.68E+01	4.00E+00	1.60%
	Manganese	µg/L	6	4	4	6.28E+02				4.94E+01	1.00E+01	5.10%
	Mercury	µg/L	13	9	4	2.86E-01				2.49E-01	1.00E+00	0.50%
	Methyl Ethyl Ketone	µg/L	211	32		2.32E+02				3.02E+03	8.00E-02	0.00%
	Methyl Isobutyl Ketone	µg/L	222	13		2.19E+02				8.36E+02	3.00E-01	0.10%

TABLE 4-2

Chemical-Specific Cumulative Risks in Groundwater

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Scenario	Parameter Name	Units	Total Samples	Total Detects	Risk Exceed.	EPC	RBSL-C	Risk ELCR*	Risk ELCR, %	RBSL-NC	Risk HI*	Risk HI, %
	Methyl Tert-Butyl Ether (MTBE)	µg/L	217	91	55	4.59E+03	1.31E+01	3.00E-04	3.20%	2.23E+03	2.00E+00	0.80%
	Naphthalene	µg/L	218	29	1	7.48E+01				1.93E+02	4.00E-01	0.20%
	Nickel	µg/L	3	3		5.60E+00				1.35E+02	4.00E-02	0.00%
	n-Propylbenzene	µg/L	28	2	1	1.91E+02				2.85E+02	7.00E-01	0.30%
	o-Xylene (1,2-Dimethyl Benzene)	µg/L	197	39	14	1.65E+02				8.82E+01	2.00E+00	0.70%
	p-Cymene (p-Isopropyltoluene)	µg/L	28	2		3.47E+02						
	Phenol	µg/L	18	8		3.38E+01				4.47E+03	8.00E-03	0.00%
	Sec-Butylbenzene	µg/L	28	3		3.47E+02				2.99E+02	1.00E+00	0.50%
	Selenium	µg/L	13	3	2	2.18E+01				1.03E+01	4.00E+00	1.70%
	Toluene	µg/L	221	89	22	1.86E+03				3.00E+02	6.00E+00	2.50%
	Trichloroethene (TCE)	µg/L	221	62	47	6.16E+01	6.80E-01	9.00E-05	0.80%	1.02E+01	6.00E+00	2.40%
	Xylenes, Total	µg/L	24	15	10	2.50E+03				8.68E+01	3.00E+01	11.50%
	Zinc	µg/L	13	5		4.85E+01				9.46E+02	5.00E-02	0.00%
<b>Total</b>								1.00E-02	100.00%		3.00E+02	100.00%
Vapor Intrusion in the Living Space – Base Resident	1,2,3-Trichloropropane	µg/L	218	11		6.99E+01	9.91E+00	7.00E-06	36.00%	1.19E+04	6.00E-03	2.20%
	1,2,4-Trimethylbenzene	µg/L	28	9		3.44E+02				7.42E+03	5.00E-02	17.20%
	1,2-Dichlorobenzene	µg/L	223	16		5.00E+01				3.72E+05	1.00E-04	0.00%
	1,2-Dichloroethane	µg/L	221	19		5.87E+01	1.41E+02	4.00E-07	2.10%	7.69E+03	8.00E-03	2.80%
	1,3,5-Trimethylbenzene	µg/L	28	4		2.09E+02				7.26E+03	3.00E-02	10.70%
	2,4-Dimethylphenol	µg/L	18	6		6.14E+00						
	2-Methylnaphthalene	µg/L	19	7		1.70E+01				3.69E+04	5.00E-04	0.20%
	2-Methylphenol	µg/L	18	7		1.47E+01						
	4-Methylphenol	µg/L	18	6		2.38E+01						
	Acetone	µg/L	166	28		1.20E+02				8.19E+05	1.00E-04	0.10%
	Arsenic	µg/L	13	6		2.03E+01						
	Barium	µg/L	13	13		1.83E+03						
	Benzene	µg/L	222	100	22	1.45E+03	2.35E+02	6.00E-06	31.50%	2.50E+04	6.00E-02	21.50%
	Benzoic Acid	µg/L	19	3		2.07E+01						
	Benzyl alcohol	µg/L	19	1		7.98E+00						
	bis(2-Ethylhexyl) Phthalate	µg/L	19	5		3.33E+00						
	Cadmium	µg/L	13	3		3.57E+00						
	Carbon Disulfide	µg/L	194	23		5.14E+01				1.25E+05	4.00E-04	0.20%
	Chloroform	µg/L	222	11		6.80E+01	9.37E+01	7.00E-07	3.70%	2.78E+03	2.00E-02	9.10%
	Chloromethane	µg/L	222	24		1.15E+02	5.30E+02	2.00E-07	1.10%	1.23E+05	9.00E-04	0.30%
	Chromium, Total	µg/L	13	5		8.01E+00						
	cis-1,2-Dichloroethene	µg/L	222	13		7.60E+01				3.44E+04	2.00E-03	0.80%
	Di-n-Butylphthalate	µg/L	19	1		3.76E+00						

TABLE 4-2

Chemical-Specific Cumulative Risks in Groundwater

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Scenario	Parameter Name	Units	Total Samples	Total Detects	Risk Exceed.	EPC	RBSL-C	Risk ELCR*	Risk ELCR, %	RBSL-NC	Risk HI*	Risk HI, %
	Ethylbenzene	µg/L	222	47	1	1.41E+02	1.90E+03	7.00E-08	0.40%	9.10E+05	2.00E-04	0.10%
	Iron	µg/L	11	9		1.84E+03						
	Isopropylbenzene	µg/L	27	3		3.51E+02				5.12E+03	7.00E-02	25.40%
	m,p-Xylene	µg/L	197	52		3.47E+02				6.69E+05	5.00E-04	0.20%
	Manganese	µg/L	6	4		6.28E+02						
	Mercury	µg/L	13	9		2.86E-01				5.16E+02	6.00E-04	0.20%
	Methyl Ethyl Ketone	µg/L	211	32		2.32E+02				1.36E+07	2.00E-05	0.00%
	Methyl Isobutyl Ketone	µg/L	222	13		2.19E+02				8.41E+06	3.00E-05	0.00%
	Methyl Tert-Butyl Ether (MTBE)	µg/L	217	91	3	4.59E+03	3.77E+04	1.00E-07	0.60%	4.84E+06	9.00E-04	0.40%
	Naphthalene	µg/L	218	29		7.48E+01				7.79E+03	1.00E-02	3.60%
	Nickel	µg/L	3	3		5.60E+00						
	n-Propylbenzene	µg/L	28	2		1.91E+02				1.27E+05	2.00E-03	0.60%
	o-Xylene (1,2-Dimethyl Benzene)	µg/L	197	39		1.65E+02				6.69E+05	2.00E-04	0.10%
	p-Cymene (p-Isopropyltoluene)	µg/L	28	2		3.47E+02						
	Phenol	µg/L	18	8		3.38E+01						
	Sec-Butylbenzene	µg/L	28	3		3.47E+02				1.56E+06	2.00E-04	0.10%
	Selenium	µg/L	13	3		2.18E+01						
	Toluene	µg/L	221	89		1.86E+03				3.21E+05	6.00E-03	2.10%
	Trichloroethene (TCE)	µg/L	221	62	14	6.16E+01	1.28E+01	<b>5.00E-06</b>	24.50%	2.20E+04	3.00E-03	1.00%
	Xylenes, Total	µg/L	24	15		2.50E+03				6.69E+05	4.00E-03	1.40%
	Zinc	µg/L	13	5		4.85E+01						
<b>Total</b>								<b>2.00E-05</b>	100.00%	1.36E+07	3.00E-01	100.00%

**NOTES:**

µg/L = Microgram(s) per liter.

EPC = Exposure point concentration.

ELCR = Excess Lifetime Carcinogenic Risk.

HI = Hazard Index.

RBSL-C = Carcinogenic Risk-Based Screening Level.

RBSL-NC = Non-carcinogenic Risk-Based Screening Level.

Risk Exceed = Number of individual samples exceeding the carcinogenic and/or noncarcinogenic Risk-Based Screening Levels.

\***Bolded values** indicate ELCR greater than or equal to  $1 \times 10^{-6}$  or HI greater than or equal to 1.0.

TABLE 4-3

Summary of Groundwater Constituents Detection Frequency  
*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Constituent	Chemical Specific ARAR (µg/L)	Total Number of Samples	Duration of Data (years)	Detection Count	Detection Frequency (percent)	Detection Count over ARAR	Frequency of Detections over the ARAR (percent)
1,2,3-Trichloropropane	NE	1,846	14.5	69	4	NA	NA
1,2-Dichloroethane	5	1,851	14.5	216	12	4	0
Benzene	5	1,852	14.5	429	23	114	6
Chloroform	80	1,851	14.5	235	13	0	0
Chloromethane	NE	1,851	14.5	79	4	NA	NA
cis-1,2-Dichloroethene	70	1,851	14.5	372	20	0	0
Ethylbenzene	700	1,851	14.5	139	8	49	3
Naphthalene	700 <sup>(1)</sup>	1,848	14.5	145	8	0	0
Methyl tertiary butyl ether	200 <sup>(1)</sup>	1,845	11.3	467	25	194	11
Toluene	1,000	1,851	14.5	264	14	77	4
Trichloroethene	5	1,852	14.5	703	38	378	20
Isopropylbenzene	NE	37	4.5	5	14	NA	NA
sec-Butylbenzene	NE	37	4.5	4	11	NA	NA
o-Xylene	10,000 <sup>(2)</sup>	1,823	14.5	145	8	0	0
m,p-Xylenes	10,000 <sup>(2)</sup>	1,823	14.5	164	9	0	0
Xylenes (total)	10,000 <sup>(2)</sup>	28	3.8	17	61	1	4
Bis(2-ethylhexyl)phthalate	6	19	4.6	5	26	2	11
Arsenic	10	38	5.2	23	61	8	21
Barium	2,000	38	5.2	38	100	5	13
Cadmium	5	38	5.2	5	13	1	3
Iron	300 <sup>(3)</sup>	132	11.3	113	86	90	68
Manganese	50 <sup>(3)</sup>	112	11.3	108	96	89	79
Mercury	2	38	5.2	14	37	0	0
Selenium	50	38	5.2	6	16	0	0

**NOTES:**

1. Utah Underground Storage Tank Tier 1 screening level.
  2. Total xylenes.
  3. U.S. Environmental Protection Agency Secondary Drinking Water Standards.
- µg/L = Microgram(s) per liter.  
 ARAR = Applicable or relevant and appropriate requirement.  
 NA = Not applicable.  
 NE = Maximum Contaminant Levels are not established.

**THIS PAGE INTENTIONALLY LEFT BLANK**

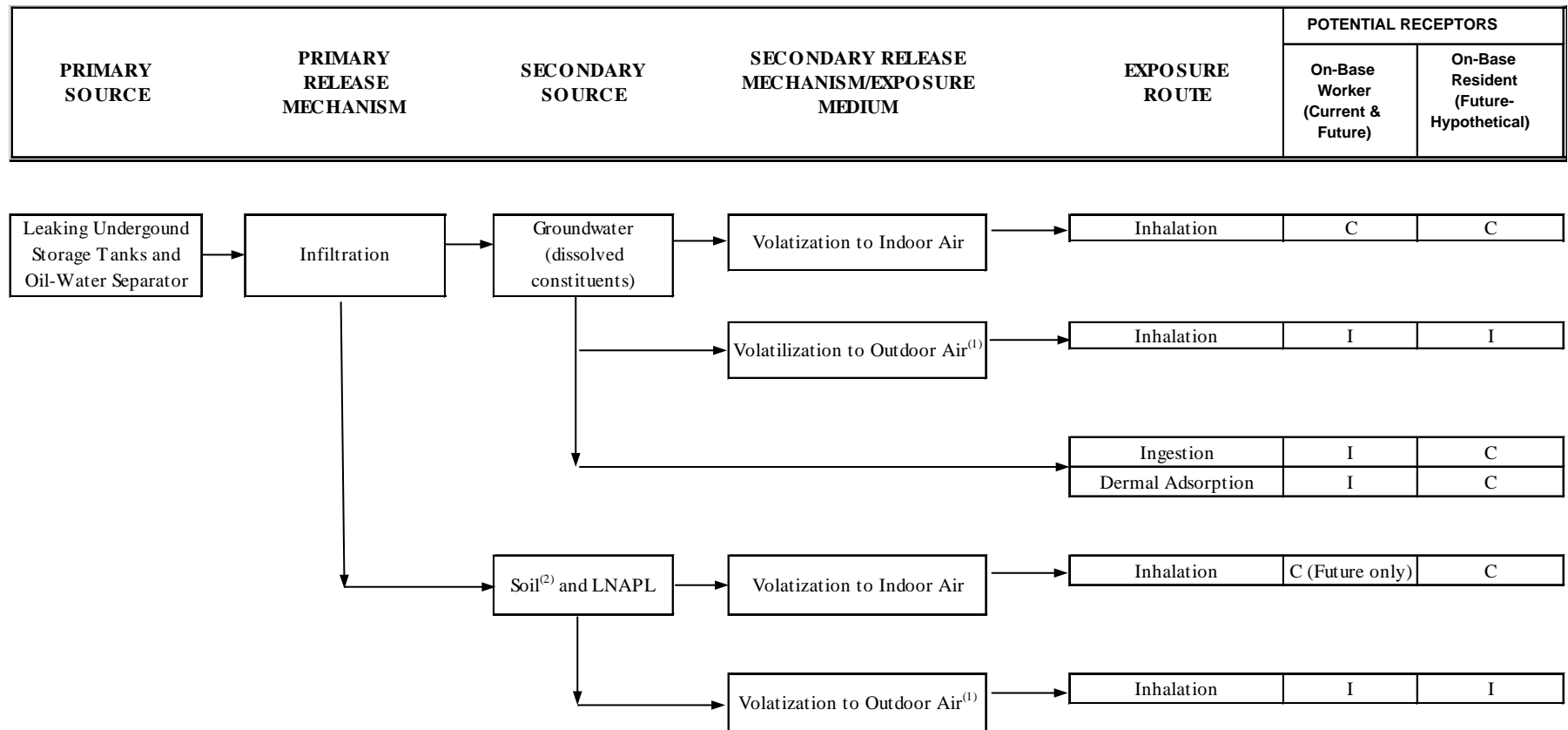


TABLE 4-4  
Summary of Cumulative Human Health Risks  
*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Contaminant Source	Scenario	Excess Lifetime Cancer Risk*	Hazard Index*
Groundwater	Hypothetical Future Residential Potable Use	<b><math>1 \times 10^{-2}</math></b>	<b>300</b>
	Vapor Intrusion in the Living Space–Future	<b><math>2 \times 10^{-5}</math></b>	0.3
	Vapor Intrusion in the Work Space–Current and Future	<b><math>1 \times 10^{-5}</math></b>	0.2
LNAPL	Vapor Intrusion in the Living Space–Future	No current impacts were identified via soil gas sampling. Potential future impacts directly over the source area will be evaluated as necessary for future construction, if any construction is planned before site cleanup goals have been met.	
	Vapor Intrusion in the Work Space–Current and Future		

\***Bolded values** indicate excess lifetime cancer risk greater than  $1 \times 10^{-6}$  or hazard index greater than 1.0.

**THIS PAGE INTENTIONALLY LEFT BLANK**



**LEGEND**

I - Incomplete or negligible exposure pathway

C - Potentially complete exposure pathway

LNAPL - Light Non-Aqueous Phase Liquid

1. Potentially complete pathway; however, the contribution was deemed insignificant compared to indoor contribution.

2. Soil impacts are within the LNAPL smear zone at the groundwater table and are attributed to residual LNAPL.



**FIGURE 4-1**  
**EXPOSURE MODEL DIAGRAM**  
 OPERABLE UNIT 11 RECORD OF DECISION  
 HILL AIR FORCE BASE, UTAH

**THIS PAGE INTENTIONALLY LEFT BLANK**

## 5.0 Remedial Action Objectives

---

Remedial action objectives (RAOs) are specific goals for protecting human health and the environment. The RAOs for OU 11 were defined in the OU 11 FS and no changes to the RAOs are proposed. The RAOs were developed to address LNAPL and contaminants in groundwater that are associated with the former releases from USTs and the vehicle repair shop OWS. The RAOs were also established to meet applicable or relevant and appropriate requirements (ARARs). ARARs are presented in Appendix A. The RAOs for OU 11 include the following and are further explained below:

- Prevent human exposure to LNAPL, contaminated groundwater, and soil vapor
- Prevent expansion of the plumes
- Restore groundwater to its expected beneficial use (e.g., drinking water), within a reasonable timeframe
- Decrease the mass of contaminants associated with the LNAPL by remediating free-phase LNAPL as well as residual LNAPL in the groundwater smear zone.

### 5.1 RAO 1

***Prevent human exposure to LNAPL, contaminated groundwater, and soil vapor***—Based on the results of the baseline risk assessment, direct exposure to contaminated groundwater could result in unacceptable risks. Thus, remedial actions must minimize the potential for human exposure to contaminated groundwater. Based on current knowledge, there is little likelihood of direct exposure to groundwater contamination for onsite personnel, hypothetical onsite residents, or offsite residents. There are no water supply wells in the shallow groundwater where the plumes reside. In addition, the contaminated groundwater at OU 11 is separated from the drinking water aquifers (Sunset and Delta) by several hundred feet of low-permeability soils, and contamination associated with OU 11 has not been detected in the drinking water aquifers. The LNAPL at OU 11 is present at the groundwater interface at thicknesses of a few inches or less. Therefore, the potential for direct exposure to LNAPL is limited due to the depth of groundwater (approximately 30-35 ft in the LNAPL area). The only potentially complete exposure pathway for current receptors is vapor intrusion in the workplace, but this pathway does not pose levels of risk considered unacceptable. While there are currently no buildings located directly above the LNAPL in the source area, there may be a risk should a building be constructed above the source area. As discussed previously, surface soil contamination has not been identified.

### 5.2 RAO 2

***Prevent expansion of the plumes***—Preventing the overall expansion of the plumes will minimize the extent of the shallow aquifer that is degraded due to the presence of contamination and will help curb the costs of the selected remedies. By preventing the migration of contaminants, a remedy meeting this RAO would satisfy the UAC R315-101-3, Principle of Nondegradation, which requires monitoring of the site and triggers corrective action if contaminant concentrations increase, and is an ARAR.

## 5.3 RAO 3

***Restore groundwater to its expected beneficial use (e.g., drinking water), within a reasonable timeframe***—Based on EPA guidelines for groundwater classification (EPA 1986), OU 11 is considered a potential future drinking water source. Based on the State of Utah Groundwater Classes (UDEQ 2013), the shallow aquifer beneath OU 11 can be classified as a Class II aquifer, meaning that it is considered a potential source for drinking water, even though it is not currently used for that purpose. However, since potable use is considered to be possible at some point in the future, it is necessary to reduce the mass of contaminants to meet acceptable levels within a reasonable timeframe. Remediation goals (RGs) have been developed for groundwater at OU 11 and are presented in Table 5-1. The RGs are developed to be protective of human health and consider the following criteria: chemical-specific ARARs, health risks below an excess lifetime cancer of  $1 \times 10^{-6}$ , and an HI less than 1.0.

Based on the risk assessment and the nature and extent of contaminants at OU 11 (Section 3.3), VOCs are the primary constituents addressed in the remedial alternatives for OU 11. Based on their temporal and spatial prevalence, BTEXN, MTBE, and TCE and its breakdown products are the primary focus for remediation, and these are included as the primary COCs in Table 5-1.

## 5.4 RAO 4

***Decrease the mass of contaminants associated with the LNAPL by remediating free-phase LNAPL as well as residual LNAPL in the groundwater smear zone***—This RAO provides direction for reducing the UST-related contamination, thereby reducing the longevity of the BTEXN plume. This RAO arises from the knowledge that free product in the subsurface soils acts as a source of contaminants to groundwater. By remediating LNAPL, a remedy that achieves this RAO would satisfy UAC R311-211-2 and -4, Source Elimination, which require source removal or control and prevention of future degradation, and are ARARs.

TABLE 5-1

Remediation Goals for Principal Contaminants of Concern in Groundwater  
*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Compound	Remediation Goal (µg/L)	Source
Benzene	5	EPA MCL
Toluene	1,000	EPA MCL
Ethylbenzene	700	EPA MCL
Xylenes	10,000	EPA MCL
Naphthalene	700	UDEQ-DERR UST Tier 1 Screening Level
Trichloroethene	5	EPA MCL
cis-1,2-Dichloroethene	70	EPA MCL
Vinyl Chloride	2	EPA MCL
Methyl Tertiary Butyl Ether	200	UDEQ-DERR UST Tier 1 Screening Level

**NOTES:**

µg/L = Microgram(s) per liter.

DERR = Division of Environmental Response and Remediation.

EPA = U.S. Environmental Protection Agency.

MCL = Maximum Contaminant Level.

UDEQ = Utah Department of Environmental Quality.

UST = Underground storage tank.

**THIS PAGE INTENTIONALLY LEFT BLANK**



## 6.0 Description of Remedial Alternatives

---

This section provides a detailed description of each of the alternatives considered for remediation of LNAPL and contaminated groundwater at OU 11. Elements common to alternative descriptions also are summarized. The specific details of the remedial alternatives are intended only to serve as examples of available types of technology to allow calculation of order-of-magnitude cost estimates. Additional remedial process options that may achieve the same objectives may be evaluated during remedial design activities for OU 11.

### 6.1 Common Elements of Remedial Alternatives

Several specific remedial components are common to all of the remedial alternatives with the exception of the No Action Alternative, including the following:

- Implementation of ICs
- MNA for dissolved-phase plumes
- SVE and manual LNAPL recovery.

Each of these components is described in greater detail in the following paragraphs.

#### 6.1.1 Institutional Controls

ICs are used when contamination remains onsite at a level that does not allow for unrestricted use or unlimited exposure. ICs are required for OU 11 due to the presence of groundwater contaminants above MCLs and to mitigate potential vapor intrusion concerns (Section 4.1). The USAF is responsible for implementing, monitoring, maintaining, reporting on, and enforcing the ICs, including specific actions as described in the Base Master Plan and the Restricted Areas Use Map. The USAF is also obligated to inform, monitor, enforce, and bind, where appropriate, authorized lessees, tenants, contractors, and other authorized occupants of the site of the ICs impacting OU 11. Where state agencies bear a significant enforcement role, the USAF will maintain regular communication with the state agencies and request appropriate notification of enforcement actions. If the USAF determines that specific IC requirements are not being met, it is understood that the remedy may be reconsidered and that additional measures may be required to protect human health and the environment. The USAF will retain ultimate responsibility for remedy integrity.

The USAF must notify the EPA and the State as soon as practicable, but no longer than 10 days after discovery, of any activity that violates or is inconsistent with the IC objectives or use restrictions, or any other action that may interfere with the effectiveness of the ICs. The USAF must take prompt measures to correct the violation or deficiency and prevent its recurrence. In this notification, the USAF will identify any corrective measures it has taken or any corrective measures it plans to take and the estimated timeframe for completing them. For corrective measures taken after the notification, the USAF shall notify the EPA and the State when the measures are complete. The USAF will conduct IC monitoring (inspection). The USAF will report to the EPA and UDEQ annually on the monitoring activities, the results of such monitoring, any changes to the ICs, and any corrective measures resulting from monitoring during the time period. The annual monitoring reports will be used in preparation of the Five-Year Review to evaluate the effectiveness of the remedy.

The USAF shall not modify or terminate ICs, implementation actions, or land uses that are associated with the selected remedy at OU 11 without the approval of the EPA and concurrence by the State. The USAF shall seek prior approval from the EPA and concurrence from the State before any anticipated action that may disrupt the effectiveness of the ICs or any action that may alter or negate the need for ICs. The USAF will provide notice to the EPA and UDEQ at least 6 months prior to any transfer or sale of OU 11 so that the EPA and UDEQ can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective ICs. If it is not possible for the facility to notify the EPA and UDEQ at least 6 months prior to any transfer or sale, then the facility will notify the EPA and UDEQ as soon as possible, but no later than 60 days prior to the transfer or sale of any property subject to ICs. In addition to the previous land transfer notice and discussion provisions, the USAF further agrees to provide the EPA and UDEQ with similar notice, within the same timeframes, for federal-to-federal transfer of property accountability. The USAF shall provide either access to or a copy of the executed deed or transfer assembly to the EPA and UDEQ.

ICs would be included in all remedial alternatives except the No Action Alternative (Alternative 1). The objective of these ICs is to prevent access or use of shallow groundwater and to prevent exposure to LNAPL and soil vapor until cleanup levels are met. Since Hill AFB is expected to remain under the jurisdiction of the DoD for the foreseeable future, the future land use for OU 11 is expected to remain industrial. The ICs selected to protect human health and the environment as described below have taken these potential future land use scenarios into account. These ICs include such actions as USAF-enforced restrictions preventing access to groundwater, prohibiting construction without concurrence from the AFCEC/CZ, and evaluation and mitigation of vapor intrusion risks for future construction. The ICs will also prohibit residential uses unless appropriate measures have been taken to mitigate any potential risks. ICs will be maintained until contaminant concentrations in groundwater are at levels that allow for unlimited use and unrestricted exposure. The USAF would notify the EPA and UDEQ in advance of any changes to the internal procedures, property ownership, or remediation status that would affect the ICs.

ICs prohibiting use of shallow groundwater on-Base have been enacted to prevent exposure until contaminants are at levels that allow for unrestricted use and unlimited exposure. Groundwater monitoring is used to track the direction and rate of movement of each contaminant plume. USAF will update and distribute annually to base organizations a Restricted Areas Use Map identifying areas where installing wells and construction activities are prohibited unless concurrence is obtained from AFCEC/CZ. The ICs cover the extent of the groundwater plumes; the current configuration is shown in Figure 1-3. In addition, digging will generally be prohibited in the area unless concurrence is obtained from AFCEC/CZ prior to digging. Also, projects requiring a Base Civil Engineer Work Request form (Air Force Form 332) will be reviewed by the AFCEC/CZ. USAF will not terminate ICs without the approval of EPA and concurrence from UDEQ. On-Base groundwater measures will include the following:

- The USAF will maintain and enforce the ICs , which prohibit any construction or other activities that will disturb contaminated soil or groundwater or interfere with remedial action equipment and facilities unless the proposed activity receives the concurrence of the AFCEC/CZ and AFLOA/JACE.
- AFCEC/CZ will review all construction proposals (Air Force Form 332) to ensure that the IC requirements are met.
- The USAF will conduct annual IC monitoring (inspection) and submit to the EPA and UDEQ an annual monitoring report describing the status of the controls and identifying any deficiencies and how they have been addressed.

Monitoring network measures will include the following:

- The USAF will provide to the EPA and UDEQ an annual monitoring report summary describing the status of the remedial systems and monitoring network.

ICs for vapor intrusion concerns can include restrictions on future construction of buildings above the source zone or requirements that engineered remedies be incorporated into building construction. To address potential future on-Base indoor air exposures (RAO 1):

No construction or other activity that will disturb the soil or groundwater, or that will interfere with remedial action equipment and facilities, or significant changes in land use (i.e., industrial use to residential) within an OU shall occur without the written approval of the AFCEC/CZ. Before approval is given, AFCEC/CZ and AFLOA/JACE will review the proposed project or activity to determine whether it is prohibited by the terms of the OU's ROD and approve only actions that will not interfere with the restrictions contained in the ROD or otherwise adversely affect an OU.

When a planned activity interferes with a ROD or when there is a question about whether a proposed activity is prohibited by a ROD, the activity will be allowed only with the approval of the EPA and concurrence from UDEQ.

While no buildings are currently located directly above the LNAPL in the source area, there may be a risk should a building be constructed above the source area. Consistent with the standing order DERP Manual, DODM 4715.20, evaluation and mitigation of future vapor intrusion risk is required before any future construction at OU 11. If an unacceptable vapor intrusion risk is identified, the USAF will perform mitigation measures that could include, but are not limited to, removing the source of soil gas contamination before construction or implementing physical controls during construction of the buildings (i.e., passive or active subslab vapor mitigation). No unacceptable risks have been identified due to vapor intrusion for current workers.

### 6.1.2 Monitored Natural Attenuation

MNA is the process by which contaminant concentrations are reduced by various naturally occurring physical, chemical, and biological processes. Natural attenuation relies upon natural processes without human intervention to assist in the reduction of contaminant concentrations. However, natural attenuation processes would be carefully monitored to evaluate their effectiveness.

The application of this method depends on site-specific data (i.e., type, concentration, and interaction of contaminants and the biological, chemical, and physical characteristics of the site). Fuel-related VOCs and chlorinated solvents such as TCE are commonly evaluated for natural attenuation. Evidence of natural attenuation occurring at OU 11 was evaluated in the FS, and is summarized in Section 3.3.2.

MNA is included as a component of all of the remedial alternatives except Alternative 1 (No Action). The groundwater monitoring program would be developed during the remedial design phase. An estimate of the number of wells and frequency of sampling were assumed for remedy cost estimates. Detailed cost estimates for all alternatives are included in the OU 11 FS (CH2M HILL 2011).

### 6.1.3 Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery

SVE and manual LNAPL recovery are included as components of all of the remedial alternatives except Alternative 1 (No Action) to address LNAPL. SVE is an in situ treatment technology used to address contamination in the vadose zone. SVE wells are installed near the source of contamination, and a vacuum is applied through the wells. The vacuum causes volatile contaminants to evaporate, and the vapors are drawn into the wells by the vacuum pressure. SVE was previously conducted at five existing site wells but was shut down due to the submergence of the well screens below the water table, and the SVE equipment was demobilized from the site. An estimate of the number of new SVE wells to be installed was assumed for remedy cost estimates. However, the final configuration of the SVE system will be developed during the remedial design phase. Vapor monitoring would be required for any remedy using SVE, and the monitoring program will be developed during the remedial design phase.

Manual LNAPL removal was initiated in October 2000, and consists of using either passive LNAPL skimmers or bailers to remove LNAPL from wells where the measured thickness is greater than 1 inch. Manual LNAPL recovery would continue with any of the remedial alternatives except Alternative 1 (No Action).

## 6.2 Description of Alternatives

### 6.2.1 Alternative 1: No Action

- This option assumes that all currently ongoing activities at the site would cease and no other actions would occur in the future.

Alternative 1 consists of taking no action. The NCP requires that a No Action Alternative be retained throughout the alternatives evaluation process as a baseline against which to compare the other approaches. Under this alternative, no mechanisms would be in place to prevent or control exposure to contaminants. Alternative 1 allows unmonitored natural attenuation to reduce contaminants in groundwater and to attenuate LNAPL. However, since no monitoring is associated with the No Action Alternative, no effort would be expended to ascertain whether such attenuation is occurring. Lack of active cleanup or controls may allow users to be exposed to contaminants even as natural attenuation occurs. However, exposure at this site is unlikely because shallow groundwater in the area of Hill AFB is typically not used as a potable water source, and groundwater is deeper than 10 ft bgs at OU 11.

There are no capital or operation and maintenance (O&M) costs for Alternative 1. The estimated timeframe for the contaminants to attenuate to concentrations below the RGs is 32 years.

### 6.2.2 Alternative 2: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Monitored Natural Attenuation and Institutional Controls for the Dissolved-Phase Plumes

- **Source**—The LNAPL will be treated by SVE and manual LNAPL recovery activities. Manual LNAPL recovery would consist of a continuation of the current bailing activities. In addition, vacuum-enhanced recovery will be considered if sufficient LNAPL thickness and recoverability is observed at the time that the remedy is implemented.
- **Dissolved Plumes**—The focus on this remedy is for the plumes to naturally degrade through biological and physical processes. This option includes sampling budgets and installation of

monitoring wells over the projected life cycle of the plumes. ICs restricting groundwater use would continue until the plumes are fully remediated, and the USAF would continue to maintain the property above these plumes as industrial areas. The ICs for Alternatives 2 through 5 are identical and are not addressed further within each alternative.

As discussed in Section 3.0, the extent of the BTEXN and TCE plumes appears to be stable or receding, and contaminant degradation is occurring. Based on the stable nature of the BTEXN and TCE plumes and the potential for natural attenuation, MNA with ICs appears to be a suitable strategy for managing the BTEXN and TCE plumes. Unlike the BTEXN and TCE plumes, the MTBE plume appears to be expanding toward the southwest. While MTBE degradation products, TBA and acetone, are present in OU 11 groundwater, the presence of these compounds does not confirm that MTBE degradation is occurring at the site, as these constituents may have come from other sources or, in the case of TBA, may have been present in the same source as the MTBE. The compound-specific isotopic analysis, along with the Bio-Trap and stable isotope probe investigation for MTBE degradation conducted in 2006, 2007, and 2010, indicated that while little or no isotopic fractionation of MTBE is occurring, some aerobic microbial degradation of MTBE is occurring in the aquifer.

Natural attenuation of MTBE predominantly relies on aerobic and cometabolic processes that do not necessarily result in isotopic fractionation, along with nondestructive physical processes (dilution, dispersion, volatilization, etc.). Based on observed site conditions and computer simulation, MNA with aerobic biodegradation for mass reduction will likely degrade MTBE to concentrations below the RG within the confines of Hill AFB property. To monitor the progress of MNA, an additional eight monitoring wells may need to be added to monitor the MTBE plume at the 200-µg/L RG. These eight additional wells are included in the cost estimate for the MNA remedy.

A select number of existing monitoring wells (approximately 80) will be sampled for performance monitoring of the remedy. Yearly monitoring of 80 monitoring wells was assumed for cost estimating purposes; the actual number of wells and sampling frequencies will be determined during the development of the remedial design for the selected alternative. Natural attenuation of the MTBE, BTEXN, and TCE concentrations will continue to be assessed through performance monitoring until the RAOs and RGs have been achieved.

Using groundwater modeling, it was estimated that a total remediation timeframe of 32 years would be required to meet RAOs for the MTBE plume, 13 years for the TCE plume, and 7 years for the BTEXN plume under Alternative 2. Capital, O&M, and total present worth costs for Alternative 2 are presented in Table 6-1.

### 6.2.3 Alternative 3: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Mass Removal, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes

- **Source**—The LNAPL will be treated by SVE and manual LNAPL-recovery activities. Manual LNAPL recovery would consist of a continuation of the current bailing activities. In addition, vacuum-enhanced recovery will be considered if sufficient LNAPL thickness and recoverability is observed at the time that the remedy is implemented.
- **Dissolved Plumes**—The focus of this active remedy is to provide mass removal of contaminants downgradient of the source zone. This system will minimize further downgradient migration and remove primarily MTBE mass with a secondary benefit of removing TCE mass. Once the LNAPL in the source area is removed, MNA will be the primary mechanism for reducing

dissolved BTEXN and TCE concentrations. MNA and ICs will also be used for residual MTBE following active remediation. To mitigate any potential risks, ICs will be maintained until RGs are met.

Figure 6-1 presents a conceptual layout of Alternative 3, including the IC boundaries and the mass removal well network. A select number of existing and newly installed monitoring wells will be sampled to monitor system performance during active remediation. After terminating system operation, a subset (assumed 20 for costing purposes) of these monitoring wells, identified as the compliance wells, will continue to be monitored to assess natural attenuation of the residual dissolved-phase concentrations until the RAOs have been achieved.

Mass removal will be achieved by installing groundwater extraction wells with screened intervals within the MTBE plume. The numerical modeling for the mass removal alternative estimated a total groundwater extraction rate of 20 gallons per minute using four extraction wells. Groundwater extraction would be effective for mass removal and limiting migration of the MTBE plume and less effective for treating the TCE and BTEXN plumes due to the lower mobility of these contaminants in the aqueous environment, illustrated by their higher soil adsorption coefficients.

The modeled MTBE concentrations in the extracted groundwater appear to exceed the discharge limit for total toxic organics to the local North Davis Sewer District publicly owned treatment works (POTW). The discharge limit for total toxic organics to the POTW is 2.13 milligrams per liter (mg/L). The current maximum MTBE concentration in the treatment area is greater than 4 mg/L. If verified upon implementation of this alternative, pretreatment of the system effluent stream may be necessary before discharge to the sanitary sewer (e.g., pump-and-treat configuration). Extracted groundwater would be piped to a system consisting of bag filters; an air stripper; liquid-phase granular-activated carbon; and associated pumps, blowers, and controls. The treated groundwater would be discharged to the sanitary sewer for additional treatment at the local POTW. It was assumed that pretreatment of the extracted groundwater would be required for cost estimating purposes. However, if the effluent stream from the hydraulic containment and/or mass removal systems is less than the total toxic organics limit, then the extracted groundwater will not require pretreatment and can be discharged directly to the sanitary sewer for treatment at the POTW.

Alternatives 3 through 5 assume that a limited number of wells would be sampled as part of the performance monitoring. During the first 10 years of active remediation, it is assumed that a total of 14 wells would be sampled semiannually, with an additional 26 wells sampled annually. For the eleventh year and beyond, a total of 20 wells were assumed to be sampled annually. The number of sampling points and frequencies were assumed for cost estimating purposes; the actual number of wells and sampling frequencies will be determined during the remedial design phase for the selected alternative. For cost estimating and modeling purposes, it has been assumed that active remediation will continue for a maximum of 10 years, after which SVE, manual LNAPL removal, and hydraulic mass removal will cease.

After approximately 10 years of active remediation, it was assumed that active treatment will have reached a point of diminishing returns with respect to contaminant mass removal, and back diffusion of contaminants out of the fine-grained materials will probably be negligible. Using this assumption, the modeling estimated a total remediation timeframe of 17 years to remediate the MTBE plume, 12 years for the TCE plume, and 11 years for the BTEXN plume under Alternative 3. The reason for the slight increase in remediation timeframe for the BTEXN compounds between Alternatives 2 and 3 is created by mass removal via groundwater extraction dropping the groundwater elevations. This drop in water table elevations isolates a portion of the BTEXN compounds in the vadose zone where degradation in the model is slightly slower resulting from a lack of advection and dispersion. However, since the

groundwater model does not simulate the effects of the SVE system, the final remediation timeframe for BTEXN in Alternative 3 is likely to be shorter than the 11 years predicted by the groundwater model.

Capital, O&M, and total present worth costs for Alternative 3 are presented in Table 6-1.

#### 6.2.4 Alternative 4: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; Enhanced Aerobic Biodegradation, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes

- **Source**—The LNAPL will be treated by SVE and manual LNAPL recovery activities. Manual LNAPL recovery would consist of a continuation of the current bailing activities. In addition, vacuum-enhanced recovery will be considered if sufficient LNAPL thickness and recoverability is observed at the time that the remedy is implemented.
- **Dissolved Plumes**—The focus of this active remedy is to implement enhanced aerobic biodegradation for treating the dissolved MTBE, TCE, and BTEXN plumes. The focus of this alternative will be to promote aerobic degradation of the contaminants via direct microbial processes or through aerobic cometabolic processes. Once the active remediation has been concluded, the residual MTBE, BTEXN, and TCE will be addressed by MNA. To mitigate any potential risks, ICs will be maintained until RGs are met.

Alternative 4 consists of in situ remediation of the core of the dissolved-phase MTBE plume (concentrations greater than 1,000 µg/L). This alternative would use aerobic remediation systems, which could include the installation of Waterloo Emitters™, air sparging, and/or the injection of substrates that are identified as limiting factors for the natural aerobic decay processes. Once enhanced aerobic biodegradation has met its cleanup goal, the residual contaminants will be degraded through MNA, with ICs in place until the site is closed.

For costing purposes and evaluation of the alternative with the NCP criteria, an air sparging system was carried through the evaluation. Air sparging was chosen for costing since it is anticipated to have the median cost for this remedial approach. The air sparging system will enhance aerobic degradation of the dissolved-phase MTBE through biodegradation via indigenous aerobic microbes and aerobic cometabolism stimulated by air injection and through volatilization. Air sparging will remove TCE by volatilization to a lesser extent than MTBE, but aerobic conditions generated by air sparging activities will promote the cometabolism of the TCE. SVE is provided in the costing processes to capture and treat vapors in the vadose zone that are potentially generated by the air sparge system and thereby reduce indoor air risk potential. Active remediation of the LNAPL will include SVE and manual LNAPL recovery.

Figure 6-2 presents a conceptual layout of the air sparge and SVE well networks. Air sparge and SVE operations will be implemented within the middle and upgradient portions of the MTBE plume. The air sparge wells will intercept and degrade dissolved-phase MTBE within accessible areas of the plume greater than 1,000 µg/L to reduce the overall remediation timeframe. The air sparge well network becomes progressively deeper from northeast to southwest to correspond with the depth of the MTBE plume. A total of 34 air sparge wells and 10 SVE wells were assumed in the evaluation of Alternative 4 (Figure 6-2).

A select number of existing and newly installed monitoring wells will be sampled to monitor the performance of the in situ remedies during active remediation. After terminating the active remedies, a

subset (assumed 20 for costing purposes) of these monitoring wells, identified as the compliance wells, will continue to be monitored to assess natural attenuation of the residual dissolved-phase concentrations until the RAOs have been achieved. For cost estimating and modeling purposes, it was assumed that active remediation will continue for a maximum of 10 years. It was also assumed that a 60 percent effective removal rate during active remediation will be achieved. Using these assumptions, the modeling estimated a total remediation timeframe of 29 years to remediate the MTBE plume, 9 years to remediate the TCE plume, and 7 years to remediate the BTEXN plume under Alternative 4. This implies that residual MTBE concentrations in groundwater will require an additional 19 years to naturally attenuate. However, actual remediation timeframes may vary due to the presence of interbedded sand, silt, and clay units. The heterogeneous stratigraphy may limit the effectiveness of the air sparge system to generate aerobic conditions and treat groundwater across the targeted saturated thickness of the MTBE plume. Anaerobic zones will persist within lower-permeability layers and layers through which air is not being channeled. Depending on the efficiency of mass degradation provided by the applied alternative, additional monitoring wells may be required to monitor the plume once active treatment is discontinued and the plume is under MNA.

Capital, O&M, and total present worth costs for Alternative 4 are presented in Table 6-1.

## 6.2.5 Alternative 5: Soil Vapor Extraction and Manual Light Non-Aqueous Phase Liquid Recovery for the Source Area; In Situ Chemical Oxidation, Monitored Natural Attenuation, and Institutional Controls for the Dissolved-Phase Plumes

- **Source**—The LNAPL will be treated by SVE and manual LNAPL recovery activities. Manual LNAPL recovery would consist of a continuation of the current bailing activities. In addition, vacuum-enhanced recovery will be considered if sufficient LNAPL thickness and recoverability is observed at the time that the remedy is implemented.
- **Dissolved Plumes**—The focus of this active remedy is to treat the dissolved MTBE, TCE, and BTEXN plumes by in situ chemical oxidation (ISCO). Once the active remediation phase has concluded, the residual MTBE, BTEXN, and TCE will be addressed by MNA following any contaminant rebound. To mitigate any potential risks, ICs will be maintained until RGs are met.

Alternative 5 consists of ISCO application, MNA, and ICs. Organic contaminants will be mineralized to innocuous compounds by injecting oxidizing reagents into the saturated zone at strategic points within the plume. In addition, ongoing SVE and manual LNAPL recovery activities will continue to be implemented within the LNAPL area north of 6<sup>th</sup> Street. A select number of existing and newly installed monitoring wells will be sampled to monitor the performance of the in situ remedies during active remediation. After terminating the active remedies, a subset (assumed 20 for costing purposes) of these monitoring wells, identified as the compliance wells, will continue to be monitored to assess natural attenuation of the residual dissolved-phase concentrations until the RAOs have been achieved.

The success of ISCO is dependent on the geochemical conditions of the aquifer, residence time of the reagent, amount of reagent used, and effective contact with the COCs. Intermediate compounds may form during oxidation; however, assuming that sufficient oxidant is present, these should be oxidized further as the oxidation process progresses. Direct contact between the oxidant and the COCs is a key aspect of destroying organics by oxidation. However, because the plume is present within the interbedded sand, silt, and clay unit, it is uncertain what the true effectiveness of ISCO reagent delivery will be. In stratified deposits, oxidants may be channeled laterally along preferential pathways rather than vertically through the saturated thickness.



This alternative requires constructing wells and operating, maintaining, and monitoring the wells and injection equipment. Two oxidants were evaluated for ISCO treatment (hydrogen peroxide and sodium persulfate). Peroxide was determined effective but not safe to handle compared with persulfate. In addition, the hydroxyl radical formed via Fenton's chemistry in the use of peroxide is not as stable as the sulfate radical. Therefore, the sulfate radical persists longer and can therefore travel greater distances in the subsurface.

Sodium persulfate will be pumped through the saturated thickness of approximately 20-25 ft through injection wells in areas where the MTBE concentration is greater than 1,000 µg/L. Injection wells will be constructed with a 10-ft screen and be separated 5 ft vertically throughout the saturated thickness. Figure 6-3 presents a conceptual layout of the ISCO injection well networks. Two ISCO well transects (rows) were assumed; with each transect containing multiple injection points approximately 25 ft apart. Two-well clusters were assumed at each injection point shown on Figure 6-3, for a total of 54 ISCO injection wells.

The assumptions for performance monitoring are summarized in Section 6.2.3. For cost estimating and modeling purposes, it was assumed that oxidant (sodium persulfate) application would occur at strategic well locations four times per year for a period of up to 10 years, and a 70 percent contaminant removal rate (from the dissolved phase) would be achieved. Using these assumptions, the model estimated a total remediation timeframe of 29 years to remediate the MTBE plume and 9 and 7 years to remediate the TCE and BTEXN plumes, respectively. However, as with the aerobic biodegradation alternative, the interbedded nature of the geologic formation may result in actual remediation timeframes varying from those predicted. The BTEXN and TCE plumes are anticipated to degrade to below the RG within the 10 years of active remediation, while MTBE will require an additional 19 years to naturally attenuate. Depending on the efficiency of mass destruction provided by the applied alternative, additional monitoring wells may be required to monitor the plume once active treatment is discontinued and the plume is under MNA.

Capital, O&M, and total present worth costs for Alternative 5 are presented in Table 6-1.

## 6.3 Distinguishing Features of Alternatives

This section presents distinguishing features of each alternative, including key ARARs associated with each alternative, estimated time for design and construction, estimated time to reach RAOs, the estimated capital costs, annual O&M costs, present worth costs, and the expected outcome of each alternative. This information is summarized in Table 6-1.

As presented in Table 6-1, the five alternatives include the following:

1. No Action, where all current activities at the site would cease, and no other actions would occur in the future
2. SVE and manual LNAPL recovery for the source area with MNA and ICs for the dissolved-phase plumes
3. SVE and manual LNAPL recovery for the source area with mass removal, MNA, and ICs for the dissolved-phase plumes

4. SVE and manual LNAPL recovery for the source area with enhanced aerobic biodegradation, MNA, and ICs for the dissolved-phase plumes
5. SVE and manual LNAPL recovery for the source area with ISCO, MNA, and ICs for the dissolved-phase plumes.

As shown in Table 6-1, the same key ARARs apply to each alternative. A detailed description of each ARAR is presented in Appendix A. In addition, the State of Utah Pollutant Discharge Elimination System pretreatment rules are applicable to Alternative 3. The relative performance of each alternative is described in detail in Section 7.0, which includes a comparative analysis of each alternative against the nine NCP criteria.

As shown in Table 6-1, the key distinguishing features between each of the alternatives are the capital and total present worth costs. In addition, there is a significant difference in the remedial timeframe between Alternative 3 (17 years) and the other alternatives (29-32 years). Therefore, based on the distinguishing features of the alternatives, the relative performance of Alternative 3 exceeds the performance of Alternatives 1, 2, 4, and 5.

**TABLE 6-1**  
Distinguishing Features of Alternatives  
*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

	Description	Key ARARs <sup>(1)</sup>	Estimated Time for Design and Construction	Estimated Time to Reach RAOs	Capital, O&M, and Total Present Worth Costs <sup>(2,3)</sup>	Long-Term Reliability of Remedy	Expected Outcome
1	No Action	<ul style="list-style-type: none"> <li>• 40 CFR 141.50<sup>(4)</sup></li> <li>• UAC R315-101<sup>(5)</sup></li> <li>• UAC R311-211<sup>(6)</sup></li> </ul>	Not applicable	32 years	Capital Costs = \$0 O&M = \$0  <b>Estimated Present Worth Cost: \$0</b>	No action taken	Groundwater concentrations will eventually meet the RGs through natural attenuation. However, there will be no monitoring to ensure that concentrations are attenuating, and no ICs to prevent exposure.
2	SVE and manual LNAPL recovery for the source area; MNA and ICs for the dissolved-phase plumes	<ul style="list-style-type: none"> <li>• 40 CFR 141.50<sup>(4)</sup></li> <li>• UAC R315-101<sup>(5)</sup></li> <li>• UAC R311-211<sup>(6)</sup></li> </ul>	6 months	32 years	Capital Costs = \$505,000 O&M Years 1-10 = \$304,000 O&M Years 11+ = \$162,000  <b>Estimated Present Worth Cost: \$5,010,000</b>	MNA will require a longer remedial timeframe to achieve RAOs. However, it is anticipated the remedy can achieve RAOs. ICs will remain in place until RAOs are met.	Expected to meet RAOs.
3	SVE and manual LNAPL recovery for the source area; mass removal, MNA, and ICs for the dissolved-phase plumes	<ul style="list-style-type: none"> <li>• 40 CFR 141.50<sup>(4)</sup></li> <li>• UAC R315-101<sup>(5)</sup></li> <li>• UAC R311-211<sup>(6)</sup></li> <li>• UAC-R317-8-8<sup>(7)</sup></li> </ul>	10-12 months	17 years	Capital Costs = \$2,399,000 O&M Years 1-10 = \$397,000 O&M Years 11+ = \$56,000  <b>Estimated Present Worth Cost: \$6,200,000</b>	Expected to achieve RGs through a combination of active groundwater remedy and MNA. ICs will remain in place until RAOs are met. This alternative is anticipated to address MTBE within a much shorter timeframe than other alternatives.	Expected to meet RAOs.

TABLE 6-1

## Distinguishing Features of Alternatives

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

	Description	Key ARARs <sup>(1)</sup>	Estimated Time for Design and Construction	Estimated Time to Reach RAOs	Capital, O&M, and Total Present Worth Costs <sup>(2,3)</sup>	Long-Term Reliability of Remedy	Expected Outcome
4	SVE and manual LNAPL recovery for the source area; enhanced aerobic biodegradation, MNA, and ICs for the dissolved-phase plumes	<ul style="list-style-type: none"> <li>• 40 CFR 141.50<sup>(4)</sup></li> <li>• UAC R315-101<sup>(5)</sup></li> <li>• UAC R311-211<sup>(6)</sup></li> </ul>	12-18 months	29 years	Capital Costs = \$2,892,000 O&M Years 1-10 = \$497,000 O&M Years 11+ = \$56,000  <b>Estimated Present Worth Cost: \$7,810,000</b>	Expected to achieve RGs through a combination of active groundwater remedy and MNA. ICs will remain in place until RAOs are met.	Expected to meet RAOs.
5	SVE and manual LNAPL recovery for the source area; ISCO, MNA, and ICs for the dissolved-phase plumes	<ul style="list-style-type: none"> <li>• 40 CFR 141.50<sup>(4)</sup></li> <li>• UAC R315-101<sup>(5)</sup></li> <li>• UAC R311-211<sup>(6)</sup></li> </ul>	12-18 months	29 years	Capital Costs = \$3,072,000 O&M Years 1-10 = \$2,400,000 O&M Years 11+ = \$56,000  <b>Estimated Present Worth Cost: \$23,660,000</b>	Expected to achieve RGs through a combination of active groundwater remedy and MNA. ICs will remain in place until RAOs are met.	Expected to meet RAOs.

**NOTES:**

ARAR = Applicable or relevant and appropriate requirement.

CFR = Code of Federal Regulation.

IC = Institutional control.

ISCO = In situ chemical oxidation.

LNAPL = Light non-aqueous phase liquid.

MNA = Monitored natural attenuation.

MTBE = Methyl tertiary butyl ether.

O&amp;M = Operation and maintenance.

RAO = Remedial action objective.

RG = Remedial goal.

SVE = Soil vapor extraction.

UAC = Utah Administrative Code.

1. Refer to Appendix A for additional ARAR information.

2. A discount rate of 3.75 percent was used in the cost estimates.

3. Capital and O&M costs are rounded to the nearest \$1,000. Present worth costs are rounded to the nearest \$10,000. All costs are presented as calculated for the Feasibility Study in 2008 dollars. Updated present worth costs in 2013 dollars are presented in Table 7-1.

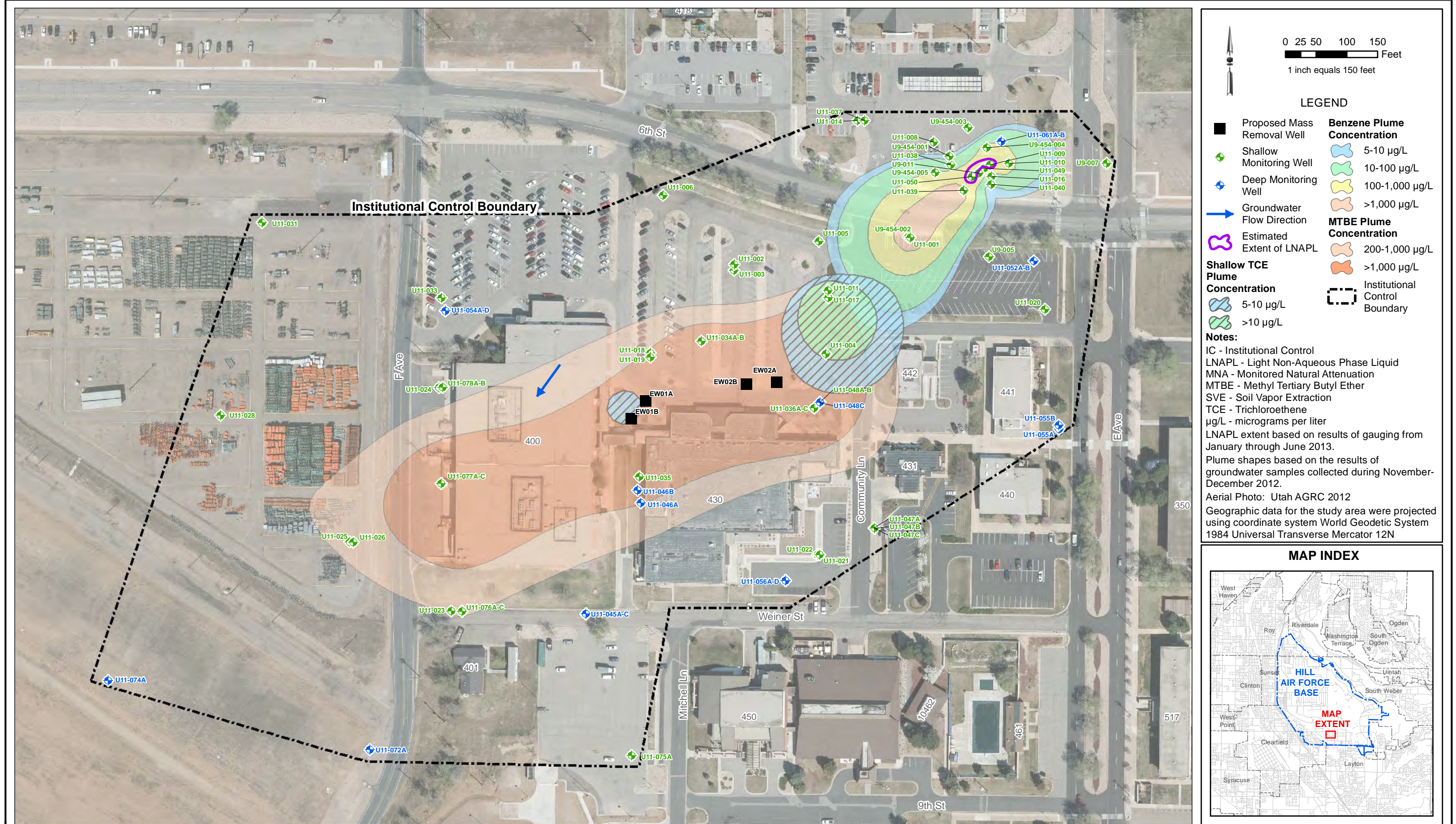
4. Federal Safe Drinking Water Act Primary Drinking Water Standards.

5. Utah Cleanup and Risk-Based Closure Standards.

6. Utah Corrective Action Cleanup Standards Policy.

7. Utah Pollutant Discharge Elimination System – Pretreatment Rules.

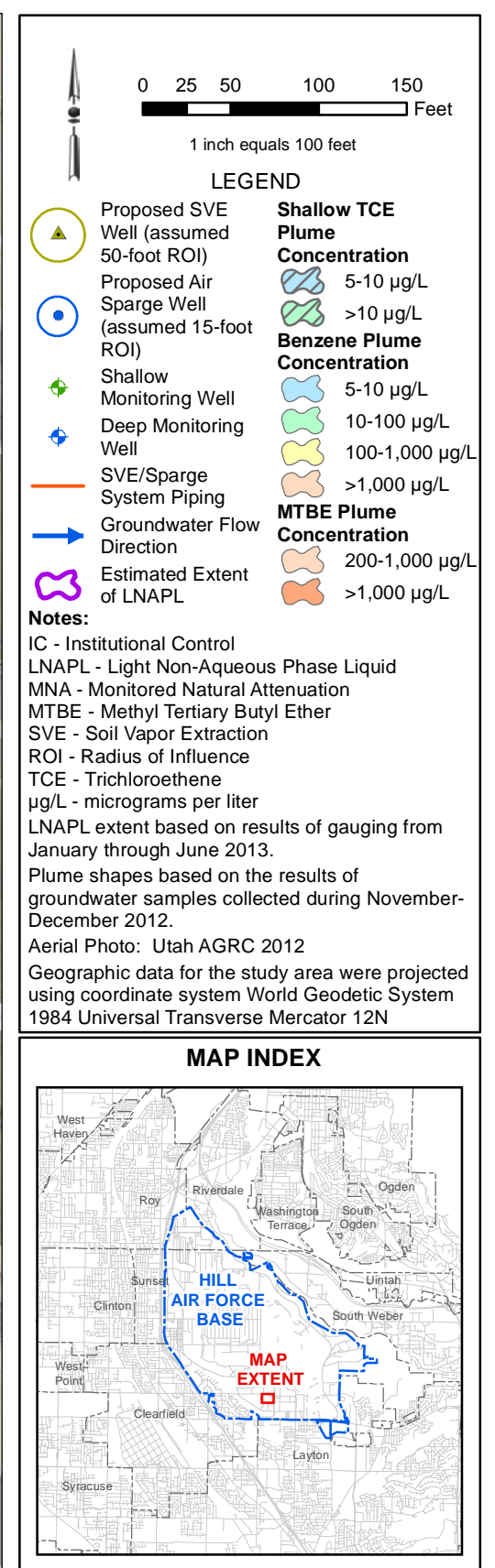






THIS PAGE INTENTIONALLY LEFT BLANK

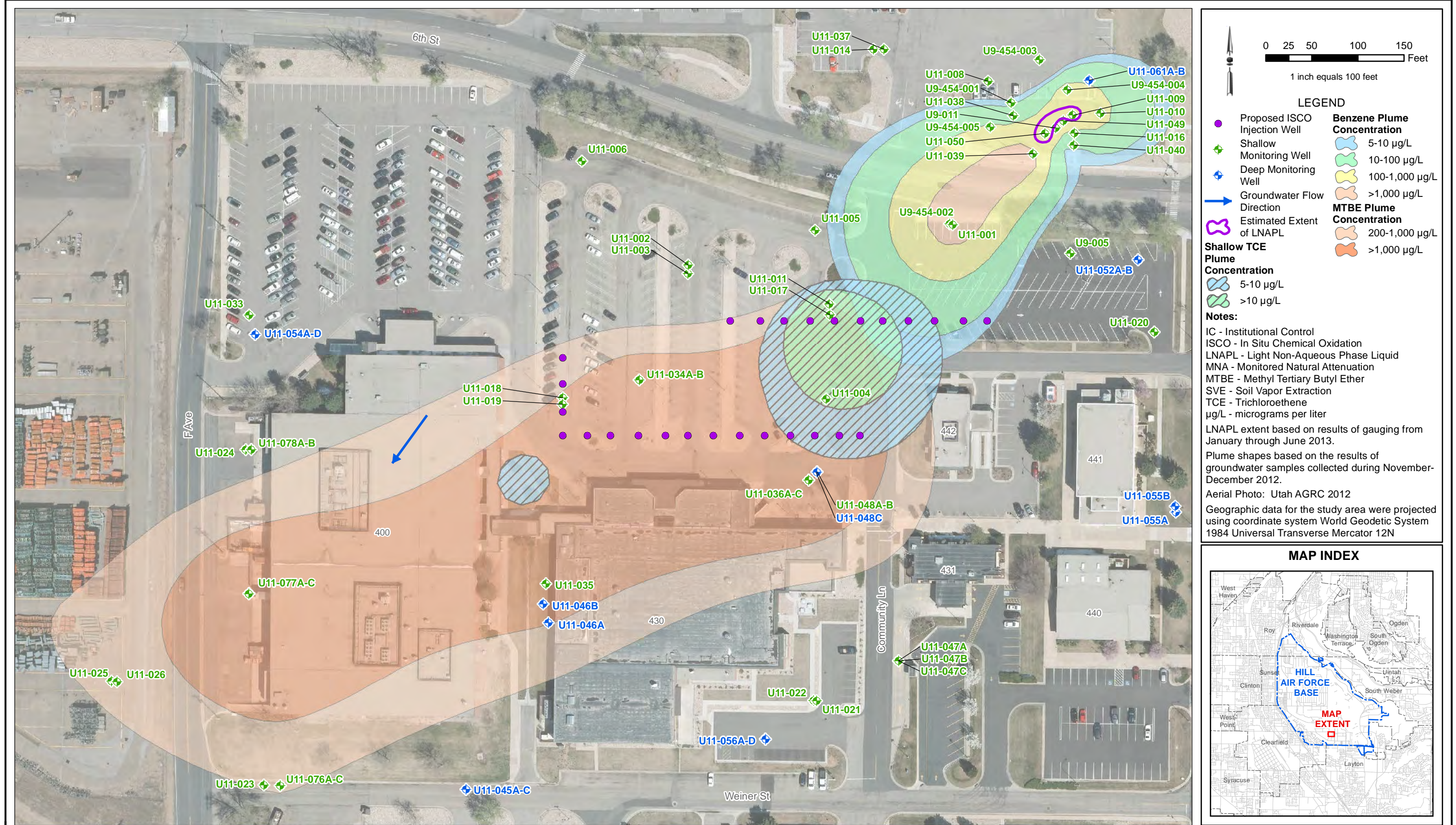






THIS PAGE INTENTIONALLY LEFT BLANK





**FIGURE 6-3**  
**ALTERNATIVE 5 - SVE AND MANUAL RECOVERY FOR THE SOURCE AREA; ISCO, MNA, AND ICS FOR THE DISSOLVED-PHASE PLUMES**  
OPERABLE UNIT 11 RECORD OF DECISION  
HILL AIR FORCE BASE, UTAH





THIS PAGE INTENTIONALLY LEFT BLANK

## 7.0 Summary of the Comparative Analysis of Remedial Alternatives

---

### 7.1 Summary of the Evaluation Criteria

This comparative analysis evaluates relative performance of the OU 11 remedial alternatives with respect to the nine evaluation criteria established in the NCP and listed as follows. The first two evaluation criteria are threshold criteria that must be met by the selected remedial actions. The next five criteria (balancing criteria) are balanced to achieve the best overall solution. The final two modifying criteria are state acceptance and community acceptance, which are considered in the remedy selection.

Threshold criteria include overall protection of human health and the environment, as well as compliance with ARARs. These threshold criteria must be met by an alternative before it can be evaluated against the five balancing criteria.

- **Overall Protection of Human Health and the Environment** determines whether an alternative eliminates, reduces, or controls threats to public health and the environment through ICs, engineering controls, or treatment.
- **Compliance with ARARs** evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified.

The five balancing criteria form the basis of the comparative analysis because they allow trade-offs among the alternatives requiring different degrees of performance.

- **Long-Term Effectiveness and Permanence** considers the ability of an alternative to maintain protection of human health and the environment over time.
- **Reduction of Toxicity, Mobility, or Volume (TMV) through Treatment** evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
- **Short-Term Effectiveness** considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation.
- **Implementability** considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.
- **Cost** includes estimated capital and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

The modifying criteria are generally addressed in response to comments from the state and the public after issuance of the Proposed Plan.

- **State/Support Agency Acceptance** indicates whether the EPA approves and the State concurs with the lead agency's (USAF's) analyses and recommendations, as described in the RI/FS and Proposed Plan.
- **Community Acceptance** considers whether the local community agrees with the lead agency's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

## 7.2 Comparative Analysis of the Alternatives

Based on the individual evaluation and assessment of each remedial alternative, a comparative analysis is presented in this section to evaluate the relative performance of the five alternatives in relation to each of the nine specific evaluation criteria. The comparative analysis identifies the advantages and disadvantages of each alternative relative to the others. A summary of the comparative analysis for the OU 11 remedial alternatives is presented in Table 7-1. The comparative analysis was initially presented in the FS and has been updated for the Proposed Plan and ROD. Therefore, Table 7-1 may differ slightly from Table 5-9 of the FS Report.

### 7.2.1 Overall Protection of Human Health and the Environment (Protectiveness)

All alternatives except Alternative 1 are protective of human health and the environment. Alternative 1 is not as protective as the remaining alternatives because it would provide protection at a slower, less predictable rate due to the expanding nature of the MTBE plume, and no ICs would be in place. Since Alternative 1 fails to meet this threshold criterion, it is not discussed further in this analysis.

Alternatives 2 through 5 are nearly equal in protecting human health and the environment through the use of source zone treatment, hydraulic containment, and/or ICs. ICs for Alternatives 2 through 5 would require evaluation and mitigation of future vapor intrusion risk before any future construction at OU 11. Therefore, these alternatives are equally protective for this potential source of exposure should any construction occur above the source area in the future. Alternatives 3 through 5 could provide greater protection by decreasing the contaminant mass through the use of the different remedial methods, which include mass removal, aerobic enhanced biodegradation, and/or ISCO.

### 7.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

ARARs are identified in Appendix A, which includes an analysis with respect to compliance for each of the alternatives. Based on the ARAR compliance discussions presented in Appendix A, Alternative 2 may not comply with ARARs because it is predicted that the MTBE plume would continue to expand under this alternative. Alternatives 3 through 5 can comply with the location-, action-, and chemical-specific ARARs. Since Alternative 2 fails to meet this threshold criterion, it is not discussed further in this analysis. Detailed information about specific ARARs is included in Appendix A.

### 7.2.3 Long-Term Effectiveness and Permanence

Alternatives 3, 4, and 5 would provide long-term effectiveness and permanence through active treatment of the source area and dissolved-phase plumes. The plumes would continue to be monitored after the

active treatment ends to detect any potential rebound in concentrations. All three alternatives include degradation and/or mass removal of contaminants, which permanently reduce the amount of contaminant present in the subsurface.

While Alternatives 3, 4, and 5 would potentially provide long-term effectiveness and permanence, the MTBE and TCE plumes are present within an interbedded sand, silt, and clay unit, which will limit the effectiveness of Alternatives 4 and 5 to treat groundwater across the entire saturated thickness of the plumes. As a result, MTBE and TCE may continue to migrate through layers not actively treated by the enhanced aerobic biodegradation and ISCO injection. A pilot test will be needed before developing a full-scale design and implementing the final remedy for Alternatives 4 and 5 to ensure the long-term effectiveness and permanence of these remedies. Therefore, the effectiveness of Alternatives 4 and 5 is less certain than the effectiveness of Alternative 3.

## 7.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The more active the treatment, the more reduction of TMV is obtained. Alternatives 3 through 5 reduce TMV through treatment by reducing the mass of LNAPL with SVE and manual LNAPL recovery. Toxicity and volume of the contaminants are reduced with Alternatives 3 through 5; however, only Alternative 3 has a significant effect on the mobility of MTBE. While Alternatives 4 and 5 do not reduce MTBE mobility, the reduction in mass of MTBE decreases the possible transport distances as compared to natural attenuation processes. The TCE and BTEXN plumes are not as mobile as the MTBE plume and are treated by Alternatives 3 through 5.

## 7.2.5 Short-Term Effectiveness

Alternatives 3 through 5 present a slight potential for short-term risks to workers during implementation of the alternatives. These risks can be controlled, but not eliminated, by following standard health and safety practices and proper construction measures and implementing traffic control plans. Specific alternatives may have higher potential for injury and fatalities due to increased activities such as driving associated with a performance monitoring program.

The environmental impacts included in this evaluation include emission intensity, material intensity, and non-renewable energy footprint (fuel and power consumption). The highest emission intensity was observed for Alternative 4 due to the large power requirements to operate this system. The largest material intensity was observed in Alternative 5, which would generate waste from the installation and development of a large number of injection wells.

Alternatives 3 through 5 would achieve RAOs through a combination of mass removal, in situ active remediation, and/or natural attenuation processes.

Groundwater modeling was used in the OU 11 FS to evaluate Alternatives 3 through 5 and to assess remediation timeframes. The MTBE plume is the driver for the overall remediation timeframe. The remediation timeframe for the TCE and BTEXN plumes is less than 13 years for all of the alternatives evaluated. Based on numeric modeling, the overall remediation timeframes for each of the alternatives are as follows:

- Alternative 3: 17 years
- Alternative 4: 29 years
- Alternative 5: 29 years.

Alternatives 3 through 5 assume a 10-year active remediation timeframe. However, the active and overall remediation timeframes are only an estimate. Variability in the site-specific geologic and hydrogeologic conditions and chemical fate and transport that cannot be completely accounted for in the modeling may affect the remediation timeframes for each alternative.

Alternatives 4 and 5 will remediate the MTBE plume within a longer timeframe and therefore will not achieve RAOs as quickly as Alternative 3. Alternatives 4 and 5 provide a similar level of protection, long-term effectiveness, and permanence through removal or destruction of contaminants.

## 7.2.6 Implementability

Alternative 3 is easily implemented, both technically and administratively. Alternatives 4 and 5 are more difficult to implement because of the large number of wells required to treat the horizontal extent and saturated thickness of the MTBE plume. In addition, Alternative 4 will require more trenching and piping compared with the other alternatives, as air lines are required between the air sparge and SVE wells and equipment buildings (Alternative 4 would include installation of new SVE/air sparge wells in addition to use of the existing wells). Alternative 4 will also require the most equipment systems, including three air sparge/SVE systems. Partial closure of parking lots and streets may be required during construction of Alternatives 3 through 5.

## 7.2.7 Cost

A summary of the cost estimates for each Alternatives 3 through 5 is provided in Table 7-1. These estimates have an accuracy of from -30 percent to +50 percent. The cost estimates include capital costs to implement the alternative, 10 years of active remediation O&M, performance groundwater monitoring and reporting, post-active remediation long-term groundwater monitoring and reporting, five-year reviews, and closure costs. The costs become progressively more expensive sequentially from Alternative 3 through Alternative 5.

## 7.2.8 State/Support Agency Acceptance

The USAF and EPA select Alternative 3 as the remedy. The State of Utah concurs with the selected remedy.

## 7.2.9 Community Acceptance

Public comment on the Proposed Plan for OU 11 was solicited to evaluate community acceptance of the preferred alternative (Alternative 3). The public meeting was held on 9 April 2014 at the Sunset City Building in Sunset, Utah. The public comment period was held from 25 March to 23 April 2014. No comments were received during the public comment period, including during the public meeting. The record of the public meeting is included in Appendix B.

## 7.3 Principal Threat Wastes

The free-phase LNAPL present in the OU 11 source area constitutes a principal threat waste. Alternatives 2 through 4 all address LNAPL in the same manner. The LNAPL will be treated by SVE and manual LNAPL recovery activities. Manual LNAPL recovery would consist of a continuation of the current bailing activities. In addition, vacuum-enhanced recovery will be considered if sufficient LNAPL thickness and recoverability is observed at the time that the remedy is implemented.

**TABLE 7-1**  
Comparative Analysis of Alternatives  
*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Alternative:	1	2	3	4	5
	No Action	SVE and manual LNAPL recovery for the source area; MNA and ICs for the dissolved-phase plumes	SVE and manual LNAPL recovery for the source area; mass removal, MNA, and ICs for the dissolved-phase plumes	SVE and manual LNAPL recovery for the source area; enhanced aerobic biodegradation, MNA, and ICs for the dissolved-phase plumes	SVE and manual LNAPL recovery for the source area; ISCO, MNA, and ICs for the dissolved-phase plumes
1. Protectiveness	▼	▲	▲	▲	▲
2. Compliance with ARARs	NA	▼	▲	▲	▲
3. Long-Term Effectiveness and Permanence	NA	NA	▲	▲	▲
4. Reduce Toxicity, Mobility, and Volume	NA	NA	▲	◄►	◄►
5. Short-Term Effectiveness	NA	NA	▲	▲	▲
6. Implementability	NA	NA	▲	◄►	◄►
7. Regulatory Acceptance	NA	NA	▲	N/A	N/A
8. Community Acceptance	NA	NA	▲	N/A	N/A
9. Cost (\$) 2008 dollars from FS	0	5,010,000	6,200,000	7,810,000	23,660,000
2013 dollars*	0	5,440,000	6,730,000	8,480,000	25,700,000
10. Estimated Cleanup Timeframe (Years)	32	32	17	29	29

**NOTES:**

- ▲ = Meets criteria
- ◄► = May meet criteria
- ▼ = Does not meet criteria

\* FS cost estimates were updated using the Consumer Price Index Inflation Calculator (U.S. Department of Labor 2013)

- ARAR = Applicable or relevant and appropriate requirement.
- FS = Feasibility study.
- IC = Institutional control.
- ISCO = In situ chemical oxidation.
- LNAPL = Light non-aqueous phase liquid.
- MNA = Monitored natural attenuation.
- NA = Not applicable.
- SVE = Soil vapor extraction.

**THIS PAGE INTENTIONALLY LEFT BLANK**



## 8.0 Selected Remedy

---

### 8.1 Description of the Selected Remedy

The selected remedy for OU 11 is Alternative 3: SVE and manual LNAPL recovery for the source area and mass removal, MNA, and ICs for the dissolved-phase plumes. Components of Alternative 3 are illustrated in Figure 6-1. The goal of the remedial action for OU 11 is to restore groundwater to RGs within a reasonable timeframe while preventing potential exposure to LNAPL and contaminated groundwater. Alternative 3 includes the following components:

- SVE in the source area
- Manual LNAPL recovery from monitoring wells
- Mass removal for dissolved groundwater plumes
- MNA for groundwater
- ICs.

#### 8.1.1 Source Area Remediation

The free-phase LNAPL present in the OU 11 source area constitutes a principal threat waste. Under the selected remedy, the LNAPL will be treated by SVE and manual LNAPL recovery activities. Manual LNAPL recovery would consist of a continuation of the current bailing activities. In addition, vacuum-enhanced recovery will be considered if sufficient LNAPL thickness and recoverability is observed at the time that the remedy is implemented.

SVE was previously conducted at five existing site wells but was shut down due to the submergence of the well screens below the water table, and the SVE equipment was demobilized from the site. It was assumed that three additional SVE wells would be installed under Alternative 3 for cost estimating purposes. However, the final configuration of the SVE system will be developed during the remedial design phase. Vapor monitoring of the SVE system would be required for Alternative 3, and the monitoring program will be developed during the remedial design phase.

Manual LNAPL removal was initiated in October 2000, and consists of using either passive LNAPL skimmers or bailers to remove LNAPL from wells where the measured thickness is greater than 1 inch. Manual LNAPL recovery would continue with implementation of Alternative 3, with the addition of vacuum-enhanced recovery if sufficient LNAPL thickness and recoverability is observed.

#### 8.1.2 Dissolved Plume Remediation

Figure 6-1 presents a conceptual layout of the mass removal well network. Mass removal will be achieved by installing groundwater extraction wells within the MTBE plume. The final configuration of the extraction wells will be determined during the remedial design phase; however, it is estimated that four extraction wells will be used with screened intervals ranging from 60 to 150 ft bgs within the MTBE plume. A total groundwater extraction rate of 20 gallons per minute was estimated during the FS groundwater modeling effort. Groundwater extraction would be effective for mass removal and limiting migration of the MTBE plume and less effective for treating the TCE and BTEXN plumes due to the lower mobility of these contaminants in the aqueous environment.

The modeled MTBE concentrations in the extracted groundwater appear to exceed the discharge limit for total toxic organics to the local POTW (North Davis Sewer District) of 2.13 mg/L. The current maximum MTBE concentration in the treatment area is greater than 4 mg/L. If verified upon implementation of this alternative, pretreatment of the system effluent stream may be necessary before discharge to the sanitary sewer. Extracted groundwater would be piped to a system consisting of bag filters; an air stripper; liquid-phase granular-activated carbon; and associated pumps, blowers, and controls. The treated groundwater would be sampled to ensure that the concentration of total toxic organics is less than 2.13 mg/L prior to discharge to the local POTW. If the effluent stream from the hydraulic containment and/or mass removal systems is less than the total toxic organics limit, then the extracted groundwater will not require pretreatment and can be discharged directly to the sanitary sewer for treatment at the POTW.

### 8.1.3 Performance Monitoring

Groundwater monitoring will continue during and after operation of the groundwater extraction wells. During the first 10 years of active remediation, it is assumed that a total of 14 wells would be sampled semiannually, with an additional 26 wells sampled annually. For the eleventh year and beyond, a total of 20 wells were assumed to be sampled annually. The number of sampling points and frequencies were assumed for cost estimating purposes; the actual number of wells and sampling frequencies will be determined during the remedial design phase. For cost estimating and modeling purposes, it has been assumed that active remediation will continue for a maximum of 10 years, after which SVE, manual LNAPL removal, and hydraulic mass removal will cease.

After approximately 10 years of active remediation, it was assumed that active treatment will reach a point of diminishing returns with respect to contaminant mass removal, and back diffusion of contaminants out of the fine-grained materials is anticipated to be negligible at this point. Use of the groundwater extraction wells will be discontinued, and remediation of the remaining dissolved groundwater plumes will continue via MNA.

### 8.1.4 Institutional Controls

ICs will remain in place for the duration of the remedy and are discussed in detail in Section 6.1.1. ICs prohibiting use of shallow groundwater on-Base have been enacted to prevent exposure until RGs are met. Groundwater monitoring is used to track the direction and rate of movement of each contaminant plume. The USAF will update and distribute annually to Base organizations a Restricted Areas Use Map identifying areas where installing wells and construction activities are prohibited unless concurrence is obtained from AFCEC/CZ. In addition, digging will be prohibited in the area unless concurrence is obtained from the USAF (AFCEC/CZ) prior to digging. Also, projects requiring a Base Civil Engineer Work Request form (Air Force Form 332) will be reviewed by AFCEC/CZ. The USAF will not terminate ICs without the approval of the EPA and concurrence from UDEQ. On-Base groundwater measures will include the following:

- The USAF will maintain and enforce the ICs, which prohibit any construction or other activities that will disturb contaminated soil or groundwater or interfere with remedial action equipment and facilities unless the proposed activity receives the concurrence of AFCEC/CZ.
- The USAF (AFCEC/CZ) will review all construction proposals (Air Force Form 332) to ensure that the IC requirements are met.

- The USAF will conduct annual IC monitoring (inspection) and submit to the EPA and UDEQ an annual monitoring report describing the status of the controls and identifying any deficiencies and how they have been addressed.

Monitoring network measures will include the following:

- The USAF will submit to the EPA and UDEQ an annual monitoring report summary describing the status of the remedial systems and monitoring network.

ICs for vapor intrusion concerns can include restrictions on future construction of buildings above the source zone or requirements that engineered remedies be incorporated into building construction. To address potential future on-Base indoor air exposures (RAO 1):

No construction or other activity that will disturb the soil or groundwater, or that will interfere with remedial action equipment and facilities, or significant changes in land use (i.e., industrial use to residential) within an OU shall occur without the written approval of the AFCEC/CZ and the AFLOA/JACE. Before approval is given, AFCEC/CZ and AFLOA/JACE will review the proposed project or activity to determine whether it is prohibited by the terms of the OU's ROD and approve only actions that will not interfere with the restrictions contained in the ROD or otherwise adversely affect an OU. When there is a planned activity that interferes with a ROD or when there is a question about whether a proposed activity is prohibited by a ROD, the activity will be allowed only with the approval of the EPA and concurrence from UDEQ.

While there are currently no buildings located directly above the LNAPL in the source area, there may be a risk should a building be constructed above the source area. Consistent with the standing order DODM 4715.20, evaluation and mitigation of future vapor intrusion risk is required before any future construction at OU 11. If an unacceptable vapor intrusion risk is identified (i.e., calculated excess lifetime cancer risk greater than  $1 \times 10^{-4}$  or non-cancer HI greater than 1.0), mitigation measures could include removing the source of soil gas contamination before construction or implementing physical controls during construction of the buildings (i.e., passive or active subslab vapor mitigation). No unacceptable risks have been identified due to vapor intrusion for current workers.

## 8.1.5 Remedial Timeframe and Cost

From the groundwater and contaminant transport modeling, it was estimated that the total remediation timeframe will be 17 years for the MTBE plume, 12 years for the TCE plume, and 11 years for the BTEXN plume. This estimate assumes 10 years of active remediation (SVE, manual LNAPL recovery, and groundwater extraction) followed by MNA until the RGs have been met for the groundwater plumes.

The estimated total present worth cost to implement the selected alternative is approximately \$6,200,000, as estimated at the time of preparation of the FS in 2008 dollars. This includes an estimated capital cost of \$2,399,000, annual O&M costs for Years 1-10 of \$397,000, and annual O&M costs of \$56,000 for the remaining years (Years 11-17) of the remedy (Table 8-1). Note that the information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within from +50 to -30 percent of the actual project cost. Updated to 2013 dollars, the estimated cost of the selected alternative is \$6,730,000 (U.S. Department of Labor 2013).

## 8.2 Statutory Determinations

Under CERCLA Section 121 and the NCP, the EPA and the USAF must jointly select remedies that are protective of human health and the environment, comply with ARARs (unless a waiver is justified), are cost effective, and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the TMV of hazardous wastes as a principal element and a bias against offsite disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

### 8.2.1 Protection of Human Health and the Environment

The selected remedy, Alternative 3, will protect human health and the environment through the treatment of LNAPL by SVE and manual recovery. By extracting contaminated groundwater for treatment and disposal, the selected remedy will also prevent further migration of the MTBE plume and will reduce the concentrations of dissolved contaminants. Remediation of groundwater contamination will continue via MNA once the groundwater extraction is discontinued. ICs will be maintained until RGs have been met in order to prevent unacceptable risks due to exposure to site COCs.

There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the selected remedy.

### 8.2.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy complies with all ARARs. The key ARARs are presented below. A complete list of ARARs and more detail are presented in Appendix A. Note that Appendix A includes a column listing the alternatives affected by each ARAR. Only ARARs pertaining to Alternative 3 are ARARs for the selected remedy.

Key ARARs include the following:

- Safe Drinking Water Act MCLs (40 Code of Federal Regulations Part 141), which specify acceptable concentration levels in groundwater that serve as potential sources of drinking water
- Utah Cleanup and Risk-Based Closure Standards (UAC R315-101) that establish requirements to support risk-based closure standards and include the Principle of Nondegradation, which requires monitoring of the site and triggers corrective action if contaminant concentrations increase
- Utah Corrective Action Cleanup Standards Policy (UAC R311-211), which establishes criteria for cleanup standards and requires source removal or control
- Utah Pollutant Discharge Elimination System – Pretreatment Rules (UAC R317-8-8), which set standards for discharge to a POTW.

### 8.2.3 Cost Effectiveness

EPA and the USAF jointly believe the selected remedy is cost effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: “A remedy

shall be cost effective if its costs are proportional to its overall effectiveness” (NCP Section 300.430[f][1][ii][D]). This was accomplished by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence, reduction in TMV through treatment, and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of this remedial alternative was determined to be proportional to its costs and hence this alternative represents a reasonable value for the money to be spent.

The estimated present worth cost of the selected remedy in 2013 dollars is \$6,730,000. The USAF believes that the cost for groundwater extraction in the selected remedy provides a significant increase in the protection of human health and the environment and is cost effective. The USAF also believes that the selected remedy will provide an overall level of protection comparable to Alternatives 4 and 5 at a significantly lower cost.

#### **8.2.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable**

The USAF has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. Of those alternatives that are protective of human health and the environment and comply with ARARs, the USAF has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element and bias against offsite treatment and disposal and considering state and community acceptance.

The selected remedy results in permanent removal of the remaining source materials (LNAPL) through SVE and manual recovery. The selected remedy satisfies the criteria for long-term effectiveness by removing LNAPL and dissolved-phase groundwater COCs. The selected remedy presents some short-term risks to site workers during implementation of the remedy, but these risks can be controlled using standard health and safety practices and are similar to risks associated with other alternatives. There are no implementability issues that set the selected remedy apart from the other alternatives evaluated.

#### **8.2.5 Preference for Treatment as a Principal Element**

By effecting source removal through SVE and manual LNAPL recovery, the selected remedy addresses potential risks posed by the site through the use of treatment technologies. SVE uses treatment as a principal element. The groundwater extraction component of the selected remedy will also incorporate treatment, either onsite or at the POTW, depending upon concentrations in the extracted groundwater. By using treatment as a significant portion of the remedy, the statutory preference for remedies that employ treatment as a principal element is satisfied.

#### **8.2.6 Five-Year Review Requirements**

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment.

## 8.3 Documentation of Significant Changes

No significant changes have been recommended or proposed for the selected remedy for OU 11 as a result of the OU 11 Proposed Plan, public meeting, and public comment period.

TABLE 8-1

Estimated Cost Summary for Selected Remedy Implementation<sup>(1)</sup>

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

<b>Capital Cost</b>	
Well Installation (general)	\$ 88,918
Groundwater Containment System	\$ 839,771
Construction Allowances	\$ 308,740
Professional Services <sup>(2)</sup>	\$ 483,951
Oversight Subtotal	\$ 123,995
Contingency	\$ 553,612
<b>Total Capital Cost</b>	<b>\$ 2,398,987</b>
<b>Annual Operations and Maintenance (Years 1-10)</b>	
LNAPL System Operation, Maintenance, and Reporting	\$ 42,380
Extraction System Operation and Well Rehabilitation	\$ 106,514
Groundwater Sampling	\$ 51,765
Reporting	\$ 47,517
Professional Services <sup>(2)</sup>	\$ 57,080
Contingency	\$ 91,577
<b>Annual Total Operations and Maintenance (Years 1-10)</b>	<b>\$ 396,833</b>
<b>Annual Operations and Maintenance (Years 11-17)</b>	
Groundwater Sampling	\$ 21,275
Reporting	\$ 14,714
Professional Services <sup>(2)</sup>	\$ 7,198
Contingency	\$ 12,956
<b>Annual Total Operations and Maintenance (Years 11-17)</b>	<b>\$ 56,143</b>
<b>Five-Year Review Cost</b>	
Five-Year Review	\$ 28,908
Professional Services <sup>(2)</sup>	\$ 5,203
Contingency	\$ 10,234
<b>Total Five-Year Review Cost</b>	<b>\$ 44,345</b>
<b>Closure Cost</b>	
Closure Report	\$ 21,717
Well Abandonment and Equipment Decommissioning	\$ 217,349
Professional Services <sup>(2)</sup>	\$ 66,938
Contingency	\$ 91,801
<b>Total Closure Cost</b>	<b>\$ 397,805</b>
<b>Total Present Worth in 2008 dollars<sup>(3)</sup></b>	<b>\$ 6,199,317</b>
<b>Total Present Worth in 2013 dollars<sup>(4)</sup></b>	<b>\$ 6,733,698</b>

**NOTES:**

1. The cost estimates provided are expected to be within from -30 to +50 percent of the actual project cost and are prepared for the sole purpose of comparison of alternatives. The alternative cost estimates are in 2008 dollars and are based on conceptual design from information available at the time of the feasibility study. The actual cost of the project will depend on the final scope and design of the remedial action, the schedule of implementation, competitive market conditions, and other variables.
2. Professional services includes project management, design/technical support, and construction management.
3. Calculated using a discount rate of 3.75 percent.
4. The cost estimate was prepared at the time of the Feasibility Study in 2008 dollars. The total present worth was updated to 2013 dollars using the Consumer Price Index Inflation Calculator (U.S. Department of Labor 2013).

**THIS PAGE INTENTIONALLY LEFT BLANK**



## 9.0 Responsiveness Summary

---

### 9.1 Overview

The purpose of this section is to present the USAF responses to general public comments on the Proposed Plan. These responses are known as the responsiveness summary and are a requirement of the CERCLA process. The EPA and UDEQ are required to review and concur with the responses to public comments before the ROD can be finalized.

### 9.2 Background on Community Involvement

The USAF followed a remedy selection process in accordance with the public participation requirements of CERCLA Sections 113(k)(2)(B)(i-iv) and 117. Additional requirements as outlined in the Hill AFB Environmental Restoration Community Relations Plan (Hill AFB 1997) were also fulfilled. The USAF meets quarterly with members of the Hill AFB Restoration Advisory Board. The Restoration Advisory Board for Hill AFB consists of approximately 25 people representing the local communities; federal, state, county, and city governments; local sewer and water districts; civic, business, and environmental groups; the USAF, and other interested parties. Restoration Advisory Board meetings are advertised in local newspapers and open to the public. Community concerns are solicited and addressed prior to making a final proposal.

The public was informed of the selected remedial actions through the following actions:

- All items contained within the Administrative Record are on file at the Administrative Record repository locations.
- A notice of availability of the Proposed Plan and opportunity for public comment was published in the Ogden Standard Examiner.
- A public meeting presenting the proposed remedy was held on 9 April 2014 at The Landing (Club Hill) at Hill AFB, Utah.
- A public comment period for the Proposed Plan was held from 25 March to 23 April 2014.
- Written comments by the public were encouraged .

### 9.3 Summary of the Public Meeting and Public Comments

An open house public meeting for OU 11 was held from 3:00 to 5:00 p.m. on Wednesday, 9 April 2014 at The Landing (Club Hill) at Hill AFB, Utah. Representatives from Hill AFB, the EPA, and UDEQ were available to explain and answer questions about the results of the investigations and the proposed remedy for OU 11. A record of the public meeting is included in Appendix B.

No comments were received during the public meeting, nor were any comments were received during the public comment period.

**THIS PAGE INTENTIONALLY LEFT BLANK**

## 10.0 References

---

- Brassel, K.E., and D. Reif. 1979. *A Procedure for Thiessen Polygons. Geographical Analysis.* Vol. 11, No. 3 (July). pp. 290-303.
- CH2M HILL. 2001a. *Comprehensive Data Evaluation for the South Area of Operable Unit 9 Site Inspection.* Hill Air Force Base, Utah. February.
- CH2M HILL. 2001b. *Subsurface Investigation Report for Underground Storage Tank Site 454 State of Utah, Department of Environmental Quality, Leaking Underground Storage Tank Site ELHM.* Hill Air Force Base, Utah.
- CH2M HILL. 2002. *2002 Corrective Action Plan—Underground Storage Tank Site 454 UDEQ-DERR Site ELHM.* Hill Air Force Base, Utah. August.
- CH2M HILL. 2005. *Remedial Investigation Report for Operable Unit 11.* Final. Hill Air Force Base, Utah. April.
- CH2M HILL. 2007. *LNAPL Analytical Results from Operable Unit 11.* Letter Report. Hill Air Force Base, Utah. February.
- CH2M HILL. 2008a. *Aquifer Test in Monitoring Wells U11-027, U11-030, U11-033, and U11-042B.* Technical Memorandum. Hill Air Force Base, Utah. 6 February.
- CH2M HILL. 2008b. *Operation and Maintenance of Underground Storage Tank Remediation System Project, Underground Storage Tank Program 2007 Summary Report for Site 454, UDEQ Lust Site ELHM.* Hill Air Force Base, Utah. April.
- CH2M HILL. 2011. *Operable Unit 11 Feasibility Study Report.* Final. Hill Air Force Base, Utah. March.
- Dames and Moore, Inc. 1996. *Subsurface Investigation Report and Corrective Action Plan for Building 454, LUST Site EIHG.* Hill Air Force Base. March.
- (U.S.) Environmental Protection Agency (EPA). 1986. *Guidelines for Ground-Water Classification under the EPA Ground-Water Protection Strategy.* Final Draft. Office of Ground-Water Protection Publication EPA/440/6-86-007.
- EPA. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under Comprehensive Environmental Response, Compensation, and Liability Act.* Interim Final. October.
- EPA. 1999. *A Guide for Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents.* July.
- EPA. 2002. *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance).* EPA530-D-02-004. November.
- Environmental Resources Program Information Management System (ERPIMS). 2012. *Database.* Hill Air Force Base, Utah. Accessed January 2013.

- Feth, J.H., D.A. Barker, L.G. Moore, R.J. Brown, and C.E. Veirs. 1966. *Lake Bonneville: Geology and Hydrology of the Weber Delta District including Ogden, Utah*. U.S. Geological Survey Professional Paper 518.
- Hill Air Force Base (AFB). 1997. *Final Environmental Restoration Community Relations Plan*. Hill Air Force Base, Utah. December.
- Hill AFB. 2013. *Hill Air Force Base General Plan*.
- Lee, H. 2009. *White Paper Result of OU-11 Groundwater Assessment with Enzyme Activity Probes*. Idaho National Laboratory. January.
- Philp, P. and T. Kuder. 2007. *Report on the Isotopic Characterization of MTBE Samples from Hill Air Force Base*. 7 January.
- Plantz, G.G., CL.L Appel, D.W. Clark, P.M. Lambert, and R.L. Puryear. 1986. *Selected Hydrologic Data from Wells in the East Shore Area of the Great Salt Lake, Utah*. U.S. Geological Survey Open File Report 86-139.
- Select Engineering Services. 2012. *The Environmental Restoration Management Action Plan*. Hill Air Force Base, Utah.
- Suthersan, S.S. 1999. *Remediation Engineering Design Concepts*. CRC Press.
- U.S. Department of Labor. 2013. CPI Inflation Calculator. Accessed 9 October 2013.  
<<[http://www.bls.gov/data/inflation\\_calculator.htm](http://www.bls.gov/data/inflation_calculator.htm)>>
- Utah Automated Geographic Reference Center (AGRC). 2012. Aerial photo for US National Grid tile (2,000 meters × 2,000 meters) 12TVL160500. Accessed at <ftp://ftp.agrc.utah.gov/Imagery/HRO20012/> during February 2013.
- Utah Department of Environmental Quality (UDEQ). 2013. *Utah Ground Water Quality Protection Program: Ground Water Classes with Protection Levels*. Updated 1 March 2013. Available online at <http://www.waterquality.utah.gov/GroundWater/gwclasses.htm>. Accessed 27 November 2013.
- Whitney, E.N. 1929. *Area Rainfall Estimates*. *Monthly Weather Review*. Vol. 57, Issue 11 (November). pp. 402-404.
- Wiedemeier, T.H., Rifai, H.S., Newell, C.J., and J.T. Wilson. 1999. *Natural Attenuation of Fuels and Chlorinated Solvents in the Subsurface*. New York: John Wiley & Sons, Inc.

**Appendix A**  
**Applicable or Relevant and**  
**Appropriate Requirements Tables**

---

**THIS PAGE INTENTIONALLY LEFT BLANK**

## APPENDIX A INDEX

Tables	Titles
A-1	Identification of Federal Chemical-specific ARARs
A-2	Identification of Federal Action-specific ARARs
A-3	Identification of Federal Location-specific ARARs
A-4	Identification of State Chemical-specific ARARs
A-5	Identification of State Action-specific ARARs
Units	Definitions
µg/L	Microgram per Liter
mg/kg	Milligram per Kilogram
mg/L	Milligram per Liter
Acronyms	Definitions
ARAR	Applicable or Relevant and Appropriate Requirement
BMP	Best Management Plan
BTEXN	Benzene, Toluene, Ethylbenzene, Xylenes, and Naphthalene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	<i>Code of Federal Regulations</i>
COC	Contaminant of Concern
EISB	Enhanced In Situ Bioremediation
EPA	United States Environmental Protection Agency
FOTW	Federally Owned Treatment Works
FR	Federal Register
HAP	Hazardous Air Pollutant
ISCO	In Situ Chemical Oxidation
LDR	Land Disposal Restriction
LNAPL	Light Nonaqueous Phase Liquid
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MNA	Monitored Natural Attenuation
MTBE	Methyl Tertiary Butyl Ether
NAPL	Nonaqueous Phase Liquid
OSR	Office of Standards and Regulations
OU	Operable Unit
PM <sub>10</sub>	Particulate Matter Less Than 10 Micrometers in Aerodynamic Equivalent Diameter
POTW	Publicly Owned Treatment Works
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
SIP	<i>State Implementation Plan</i>
SVE	Soil Vapor Extraction
SWDA	Solid Waste Disposal Act
SWPPP	Stormwater Pollution Prevention Plan
TCE	Trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
UAC	Utah Administrative Code
UIC	Underground Injection Control
USC	<i>United States Code</i>
UST	Underground Storage Tank

**THIS PAGE INTENTIONALLY LEFT BLANK**



TABLE A-1

Identification of Federal Chemical-specific ARARs

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Alternatives Affected	Compliance Comment
Safe Drinking Water Act					
Primary Drinking Water Standards	40 CFR 141.50	Establishes health-based MCLs for public water systems. MCLs are used when the MCLGs are zero.	--/Yes	2, 3, 4, 5	Although the EPA has delegated the SWDA program to the State of Utah, federal MCLs were incorporated by Utah Rule R311-211-5 and are relevant and appropriate for all remedial alternatives.
	141.61	Constituent of Concern	MCLG (mg/L)	MCL (mg/L)	
	TCE	0	0.005		
	Benzene	0	0.005		
	Toluene	1	1		
	Ethylbenzene	0.7	0.7		
	Xylenes	10	10		
EPA Drinking Water Advisory					
EPA Health Advisories for MTBE and Naphthalene	Advisory Document. Publication IDs: EPA-822-F-97-009 EPA 822-R-06-013	Nonregulatory guidance recommending that 20–40 µg/L of MTBE in drinking water would be below taste and odor thresholds for most people and would “provide a large margin of exposure (safety) from toxic effects.”  100 µg/L of naphthalene would not be expected to “cause any adverse noncarcinogenic effects for a lifetime of exposure.”	To Be Considered	2, 3, 4, 5	Because there is no maximum contaminant limit for MTBE or naphthalene, these advisory-level concentrations will be considered when developing RAOs.
Solid Waste Disposal Act					
Hazardous Waste Classification	42 USC 6901-6987 40 CFR 261	Defines the criteria for identifying hazardous wastes or environmental media that contain hazardous waste.	Yes/--	2, 3, 4, 5	The hazardous waste program has been delegated to the State of Utah, whose requirements are at least as stringent as federal ones.
Land disposal restrictions	40 CFR Part 268	Sets concentration limits for hazardous wastes that are restricted from land disposal.	Yes/--	2, 3, 4, 5	The hazardous waste program has been delegated to the State of Utah, whose requirements are at least as stringent as federal ones.
Management of soils containing hazardous waste	Contained-in Policy (63 FR 28618–28620; May 26, 1998)	Contaminated media, of itself, is not hazardous waste. However, contaminated environmental media can be subject to regulation under RCRA if it “contains” hazardous waste (that is, contains levels of contaminants that are above the waste characteristics or is contaminated with a listed hazardous waste [discussed under State chemical-specific ARARs]).	Yes, if media containing hazardous waste is generated	2, 3, 4, 5	Environmental media (e.g., soils, groundwater, sediment) containing hazardous waste must be managed as hazardous waste until it no longer contains the hazardous waste (that is, it no longer exhibits a characteristic of hazardous waste or when concentrations are below risk-based levels). This could require that groundwater removal and treatment systems be designed to meet hazardous waste tank requirements.

**THIS PAGE INTENTIONALLY LEFT BLANK**

TABLE A-2

Identification of Federal Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

<b>Standard, Requirement, Criteria, or Limitation<sup>1</sup></b>	<b>Citation</b>	<b>Description</b>	<b>Applicable/Relevant and Appropriate</b>	<b>Alternatives Affected</b>	<b>Compliance Comment</b>
Transportation of Hazardous Materials	Hazardous Materials Transportation Act, 49 CFR 171- 177	Established standards for packaging, labeling, and transporting hazardous materials (which include hazardous wastes).	--/Yes	2,3,4,5	Relevant and appropriate, if hazardous materials are encountered and transported offsite. Offsite hazardous waste transportation is regulated through RCRA authorities rather than CERCLA ARARs.

1. Although neither an ARAR or TBC requirement, work will be performed in accordance with the CERCLA Offsite Rule (40 CFR 300.440)

**THIS PAGE INTENTIONALLY LEFT BLANK**

TABLE A-3

Identification of Federal Location-Specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

<b>Standard, Requirement, Criteria, or Limitation</b>	<b>Citation</b>	<b>Description</b>	<b>Applicable/Relevant and Appropriate</b>	<b>Alternatives Affected</b>	<b>Compliance Comment</b>
Protection of Archeological Resources	43 CFR 7.4(a) and 7.5(b)(1)	May not excavate, remove, damage, or otherwise alter or deface such a resource unless by permit or exception. Must protect any such archaeological resources if discovered.	Yes/--	2,3,4,5	Applicable if intrusive activities uncover or disturb cultural resources. The proposed remedial actions will not alter or destroy any known prehistoric or historic archaeological features. However, because there is always a possibility that buried historic or prehistoric remains could be discovered during construction, mitigation measure to protect the area would be required if such a discovery were made. Substantive requirements can be met through compliance with Hill Air Force Base Integrated Cultural Resource Management Plan (January 2004).
Native American Graves Protection and Repatriation Regulations	43 CFR 10.4 (c) and (d)	Must stop activities in the area of discovery and make a reasonable effort to secure and protect the objects discovered. Must consult with Native American organization likely to be affiliated with the objects to determine further disposition.	Yes/--	2,3,4,5	Applicable if intrusive activities uncover and disturb graves.

**THIS PAGE INTENTIONALLY LEFT BLANK**



TABLE A-4

Identification of State Chemical-specific ARARs

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment	
Utah Public Drinking Water Regulations	R309-200-5(3)(b)	Sets state primary drinking water regulations for organic compounds based on MCLs in public water systems.	No/Yes	2, 3, 4, 5	These requirements are relevant and appropriate to all remedial alternatives and identical to federal MCLs. Where relevant, the RAOs are set at the MCLs for each contaminant. Contaminants without MCLs have been assigned alternative cleanup levels based on state or federal advisory levels.	
Utah Corrective Action Cleanup Standards Policy – UST and CERCLA Sites	R311-211-3 Cleanup Standards Evaluation Criteria	Establishes criteria for setting cleanup standards based on risk to human health and the environment, economics, and technology.	Yes/--	2, 3, 4, 5	These requirements are applicable to all remedial alternatives.	
	R311-211-5 Cleanup Standards	Establishes federal MCLs as the minimum cleanup standard for water-based cleanup goals. Sets air quality standards under the federal Clean Air Act as minimum cleanup standards for air-based cleanup goals. Allows for case-by-case exceptions to these minimum standards if they are not reasonably achievable.	Yes/--	2, 3, 4, 5	These requirements are applicable to all remedial alternatives.	
	R311-211-6	Establishes initial screening levels used to evaluate UST sites for No Further Action determinations.	Yes/--	2, 3, 4, 5	These requirements are applicable to all remedial alternatives.	
	UST Facility Cleanup Standards					
R311-211-2 and -4 Source Elimination	Requires source removal or control and prevention of further degradation.	Yes/--	2, 3, 4, 5	LNAPL at the site is believed to be a continuing source for BTEXN. The cleanup of LNAPL and associated contamination at OU 11 will be addressed under CERCLA and will comply with UST standards as ARARs. LNAPL does not appear to be a continuing source for MTBE. Source zone for TCE has been removed with the removal of Building 454.		

TABLE A-4

Identification of State Chemical-specific ARARs

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment						
Utah Hazardous Waste Management Requirements, General Requirements - Identification and Listing of Hazardous Waste (UAC R315-2)	R315-2-3 (a)(2)(v) Rebuttable Presumption for Used Oil	Used oil containing more than 1,000 parts per million total halogens is presumed to be a hazardous waste.	Yes/--	2, 3, 4, 5	This requirement is applicable to remedial alternatives that involve the recovery of LNAPL from groundwater.						
	R315-2-9(g) Toxicity Characteristic for Hazardous Waste	Wastes generated during construction, monitoring, or remediating the site must be characterized and managed in accordance with hazardous waste requirements. Most waste determinations will focus on whether the generated waste could be classified as toxicity characteristic waste as defined by the contaminant characteristic (e.g., a D-code hazardous waste).  Utah adopts federal rules and TCLP levels for classifying waste as hazardous waste by toxicity characteristic. For the constituents of concern, TCLP limits are as follows:	Yes/--	2, 3, 4, 5	These TCLP rules for classifying waste would be applicable to remedial alternatives that involve the generation of wastes such as remediation system filters, purge water, and soil cuttings.						
		<table><tr><th>Constituent</th><th>TCLP Extract</th></tr><tr><td>Benzene</td><td>0.5</td></tr><tr><td>TCE</td><td>0.5</td></tr></table>	Constituent	TCLP Extract	Benzene	0.5	TCE	0.5			
	Constituent	TCLP Extract									
Benzene	0.5										
TCE	0.5										
R315-2-10 (e) Listed Hazardous Wastes	Utah incorporates by reference the federal lists of hazardous wastes into their rules, including entries for spent and unused chlorinated solvents such as TCE. These wastes (or mixtures containing these wastes) are regulated as hazardous wastes.	Yes/--	2, 3, 4, 5	These hazardous waste identification rules would be applicable if the wastes disposed of at the site causing the contamination are found to be listed hazardous waste. For example, certain solvents used for degreasing are F-listed wastes (F001–F005).							

TABLE A-4

Identification of State Chemical-specific ARARs

Operable Unit 11 Record of Decision, Hill Air Force Base, Utah

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Groundwater Quality Protection (UAC R317-6)	R317-6-2 Ground Water Quality Standards	Establishes groundwater quality standards.	Yes/--	2,3,4,5	These groundwater quality standards are applicable corrective action cleanup levels for contaminated groundwater under R317-6-6.15F. The standards are the same as primary drinking water standards with few exceptions. (The levels are also consistent with the UST Facility Cleanup Standards where there is a crossover with the contaminants listed above.) Alternate corrective action concentration limits (ACACLs) can be established pursuant to R317-6-6.15.
	R317-6-3 Ground Water Classes	Establishes groundwater classes.	To Be Considered	2,3,4,5	Establishes groundwater classes which are used to determine groundwater class protection levels in UAC R317-6-4.
	R317-6-4 Ground Water Class Protection Levels	Establishes protection of groundwater levels based on groundwater classification.	To Be Considered	2,3,4,5	Ground water class protection levels are ground water pollutant concentration limits that apply to the operation of facilities that discharge or would probably discharge to ground water. Their purpose is to prevent degradation of ground water resources, but they are not intended to be used as applicable or relevant and appropriate cleanup standards under CERCLA. Protection levels are usually only a fraction of the ground water quality standards and vary according to ground water class (as defined in R317-6-3).

**THIS PAGE INTENTIONALLY LEFT BLANK**

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Corrective Action Cleanup Standards Policy - UST and CERCLA Sites	UAC R311-211	The rule addresses cleanup requirements at UST and CERCLA sites.	Yes/--	2,3,4,5	The policy is an applicable requirement that sets forth criteria for establishing cleanup standards and requires source control or removal and prevention of further degradation.
Hazardous Waste General Requirements	UAC R315-2 and R315-1 (Definitions)	These provisions outline general requirements and provide definitions for Utah Solid and Hazardous Rules.	Yes/--	2, 3, 4, 5	These provisions are applicable to management of hazardous wastes.
Hazardous Waste Generator Requirements	UAC R315-5	Requires specific procedures for accumulation, onsite temporary storage, and manifesting of hazardous waste. Incorporates 40 CFR 262.34 by reference. Waste may accumulate and be stored onsite for no more than 90 days. Containers need to be labeled, intact, compatible with the waste, kept closed except when adding waste, and inspected weekly (see 40 CFR 265 Subpart I, referenced at 40 CFR 262.34[a][1][i]). Tanks and their appurtenances (e.g., piping, pumps, secondary containment) must meet certain design and management standards (see 40 CFR 265 Subpart J, referenced at 40 CFR 262.34[a][1][iii]). Additional design and management requirements address potential air emissions; emissions control requirements are found in 40 CFR 265 Subparts AA, BB, and CC.	Yes/--	2, 3, 4, 5	All affected alternatives will comply with substantive requirements. Applicable to activities that result in onsite management of hazardous waste (soil and debris) generated during construction and operation of a remedial alternative. If tanks are needed (e.g., to manage NAPL if the NAPL is a hazardous waste), the tanks will be designed to meet the hazardous waste tank standards. The generator standards apply to temporary storage (<90 days) of hazardous wastes generated during remedial action. If wastes are managed for a longer period of time, the standards for treatment, storage and disposal facilities (R315-8) apply rather than generator requirements.
Hazardous Waste Transporter Requirements	UAC R315-6	Establishes standards for transporting hazardous wastes.	Yes/--	2,3,4,5	Applicable, if hazardous wastes are encountered and transported offsite.
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	UAC 315-8	Establishes standards for the operation of hazardous waste treatment, storage, and disposal facilities	--/Yes	2,3,4,5	Sections 8-6 (Groundwater Protection), 8-7 (Closure and Post Closure), 8-9 (Use and Management of Containers), 8-14 (Landfills), 8-17 (Air Emission Standards for Process Vents), and 8-20 (Containment Buildings) are substantive.
Emergency Controls	UAC R315-9	The rule outlines requirements for emergency controls of hazardous waste spills, including immediate action, cleanup and reporting.	Yes/--	2,3,4,5	Substantive portions of the rule would be applicable if any hazardous waste spills occurred during cleanup activities.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Cleanup and Risk-based Closure Standards	UAC R315-101	R315-101-1 Purpose, Applicability. Establishes requirements to support risk-based cleanup and closure standards at sites for which remediation or removal of hazardous constituents to background levels will not be achieved. The procedures in this rule also provide for continued management of sites for which minimal risk-based standards cannot be met.	Yes/--	2, 3, 4, 5	Applicable to all alternatives where hazardous constituents in exceedance of background concentrations are left in place.
		R315-101-2 Principle of Non-degradation. Requires removal or control of the source.	Yes/--	2, 3, 4, 5	Responsible party must immediately take appropriate action to stabilize the site either through source removal or source control.
		R315-101-3 Principle of Nondegradation. Requires monitoring of the site and triggers corrective action if concentrations increase.	Yes/--	2, 3, 4, 5	Responsible party will not allow levels of contamination in groundwater to increase beyond existing levels of contamination at the site when site management commences. If the groundwater plumes increase in concentrations then the nondegradation rule is triggered and additional measures beyond No Action or MNA (Options 1 and 2) may be needed.
		R-315-101-4 Site Characterization. Requires the site to be characterized and define areas of contamination	Yes/--	2,3,4,5	These provisions are applicable for the characterization of the site.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
		R-315-101-5 Health Evaluation Criteria, Risk Assessment. Requires an evaluation of risk to be performed	Yes/--	2,3,4,5	UAC 315-101-5 is substantive, however the reference to "zoning" does not apply because Air Force installations are not subject to zoning requirements. In addition, the report requirement in subsection 5.3 is procedural and not an ARAR.
		R-315-101-6 Risk Management: Site Management Plan and Closure Equivalency	Yes/--	2,3,4,5	Substantive portions of UAC 315-101-6 are requirements, including site management. Site management will include SVE, mass removal through groundwater extraction and treatment, LNAPL removal, monitored natural attenuation, and institutional controls as required by the ROD and as described in the remedial design/remedial action work plan.
Water Quality - Definitions and General Requirements	UAC R317-1	The rule provides definitions and general requirements for water quality in the state.	Yes/--	2,3,4,5	Applicable to activities involving surface water or groundwater.
Groundwater Quality Protection	UAC R317-6-6.15, Corrective Action Implementation	This rule contains provisions for the implementation of corrective actions.	Yes/--	2,3,4,5	R317-6-6.15 states "...the protection levels are not intended to be considered applicable, relevant or appropriate clean-up standards..." However, the action-specific groundwater corrective action requirements under R317-6-6.15 apply to contaminated groundwater, including the design criteria of R317-6-6.15E.4b. Remedies should be designed so that wastes left in place will not result in discharges to ground water in excess of ground water quality standards (or ACACLs) following corrective action.



TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
	UAC R317-6-4, Groundwater Class Protection Levels	This rule contains provisions for the operation of facilities that discharge or probably discharge to groundwater.	Yes/--	4,5	Applicable for alternatives 4 and 5 only as these alternatives include injection into the groundwater.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Utah Pollutant Discharge Elimination System (UPDES)	UAC R317-8	This rule establishes general requirements, definitions, and criteria/standards for technology based treatment for point sources and also establishes requirements for storm water runoff.	Yes/--	2,3,4,5	Substantive, non-procedural sections of UAC R317-8 are applicable; specific sub-parts are also described in greater detail below.
	UAC R317-8-3.9 (6)(d)10 and R317-8-3.9(6)(e)1, Construction Storm Water Permit Requirements	Requires that all construction disturbing 1 acre or more have a SWPPP and to implement BMP to minimize the impact of construction activities on stormwater ( <a href="http://www.waterquality.utah.gov/UPDES/stormwatercon.htm">http://www.waterquality.utah.gov/UPDES/stormwatercon.htm</a> ).	Yes/Yes	2, 3, 4, 5	The substantive requirements of a construction stormwater permit would be applicable if 1 acre or more is disturbed and relevant and appropriate if the land disturbed is less than 1 acre. These include preparing a SWPPP and following BMPs. Obtaining the permit is an administrative requirement and so would not be required.
	UAC R317-8-8, Pretreatment Rules	Sets standards for discharge to a POTW. Discharges cannot pass through the POTW and cause a violation or interfere with the POTW performance. No oil or corrosive discharges are allowed. The local POTW may develop specific limits and best management practices for the source in accordance with their approved pretreatment program.	Yes/--	3	All remedial alternatives that involve discharge to a local POTWs or FOTW will need to comply with the general requirements (such as no phase separated hydrocarbons in the discharge) and specific requirements (such as the 2.17 mg/L limit of total toxic organics). The POTW/FOTW will be contacted to obtain a copy of their pretreatment program.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Air Quality	UAC R307-101-2	Defines prohibited levels of air pollution.	Yes/--	2, 3, 4, 5	Applicable to remedial alternatives that may cause air emissions, including fugitive dust emissions during drilling or construction activities, emissions from construction equipment and vehicle exhaust, and/or emissions from soil vapor extraction systems or air stripping/air sparging systems.
	UAC R307-102-1	Prohibits the emission of air contaminants in sufficient quantities to cause air pollution as defined in UAC R307-101-2.	Yes/--	2, 3, 4, 5	Applicable to remedial alternatives that may cause air emissions, including fugitive dust emissions during drilling or construction activities, emissions from construction equipment and vehicle exhaust, and/or emissions from soil vapor extraction systems or air stripping/air sparging systems.
	UAC R307-107-2	If emissions control equipment suffers an unavoidable breakdown, operators will ensure that emission limitations and visible emission limitations are exceeded for only as short a period of time as reasonable.	Yes/--	2, 3, 4, 5	The Air Force will address the substantive aspects of R307-107-2(1)(a) through (f), with respect to addressing breakdowns, except for the reporting requirement.
	UAC R307-325	The rule requires that no person shall allow or cause volatile organic compounds to be spilled, discarded, stored in open containers, or handled in any other manner that would result in greater evaporation of VOCs than would have if reasonably available control technology (RACT) had been applied.	Yes/--	2,3,4,5	This rule is applicable because Davis County is a maintenance area for ozone.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Air Quality. Permit: New and Modified Sources	UAC R307-401	The rule establishes the application and permitting requirements for new installations and modifications to existing systems throughout the State of Utah.	Yes/--	2,3,4,5	Sections 401-8 VII (Approval Order-National Primary and Secondary Ambient Air Quality Standards), 401-9 (Small Source Exemption), 401-10 (Source Category Exemption), 401-11 (Replacement-in-Kind Equipment), 401-12 (Reduction in Air Contaminants), 401-13 (Plantwide Applicability Limits) 401-15 (Air Strippers and Soil Venting Projects), and 401-16 (De minimis Emissions from Soil Aeration Projects) are substantive.
Air Quality. Permits: Emissions Impact Analysis	UAC-R307-410	The rule establishes requirements for emissions impact analysis.	Yes/--	2,3,4,5	If the remedy does not achieve compliance with the exemption criteria of R307-401-15, the substantive requirements for emissions impact analysis (R307-410) are applicable.
	UAC R307-410-5, Documentation of Ambient Air Impacts for Hazardous Air Pollutants	Defines the procedures for conducting emission impact analyses for criteria and hazardous air pollutants. Also defines limits for de minimis exemption status under UAC R307-401-15.	Yes/--	2, 3, 4, 5	Alternatives that involve emissions from air strippers or SVE systems would be required to conduct emission impact analyses for hazardous air pollutants. This rule is applicable specifically to the de minimis exemption for air strippers and soil venting projects.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Fugitive Emissions and Fugitive Dust	UAC R307-309	This rule establishes minimum work practices and emission standards for sources of fugitive emissions and fugitive dust.	Yes/--	2,3,4,5	This rule is applicable. Different parts of UAC R307-309 may be applicable depending on the exact nature of construction activities, and some sub-parts are described in greater detail below. Portions of UAC R307-309 which are not applicable to OU 11 include R307-309-10 (Mining Activities) and R307-309-11 (Tailings Piles and Ponds).
	UAC R307-309-5, General Requirements for Fugitive Dust	General requirements for fugitive dust in nonattainment areas.  Except in cases where winds exceed 25 miles per hour and appropriate control measures are already in place, opacity caused by fugitive dust shall not exceed 10 percent at the property boundary and 20 percent onsite.	Yes/--	2, 3, 4, 5	Section IX.A.2 of the Utah SIP states that "[PM <sub>10</sub> ] controls required in the Salt Lake nonattainment area will be required in Davis County"; Utah's PM <sub>10</sub> nonattainment rules in Section R307-309 contain many applicable requirements to remedies involving trenching, drilling, and construction.
	UAC R307-309-6, Fugitive Dust Control Plan	Fugitive dust control plan.  Fugitive dust sources, including construction sites >¼ acre, must develop a fugitive dust control plan.	Yes/--	2, 3, 4, 5	Development and implementation of a fugitive dust control plan is an applicable requirement to reduce PM <sub>10</sub> levels in the neighboring nonattainment area; however, submission of the plan to the Department of Environmental Quality for approval is an administrative requirement and not applicable to CERCLA response actions.
	UAC R307-309-8, Construction and Demolition Activities, and UAC R307-309-9, Roads	To the maximum extent possible, materials should not be deposited on paved roads. Any deposits will be cleaned up promptly.	Yes/--	2, 3, 4, 5	Any remedy that involves trenching or drilling on paved surfaces will have to clean these surfaces to reduce fugitive dust emissions.

TABLE A-5

Identification of State Action-specific ARARs

*Operable Unit 11 Record of Decision, Hill Air Force Base, Utah*

Standard, Requirement, Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate	Alternatives Affected	Compliance Comment
Well Drilling Standards	UAC R655-4-1 thru -13	Standards for drilling and abandonment of wells. Includes such requirements as performance standards for casing joints, requirements for abandoning a well, etc.	Yes/--	2, 3, 4, 5	All affected alternatives will comply. Relevant to extraction, injection, and monitoring well construction or replacement. While substantive requirements are largely found in the monitoring well construction standards in R655-4-13, the remaining administrative requirements (relating to driller licensing, start cards, and well logs) will also be considered.
Underground Injection Control (UIC) Program	UAC R317-7-5.3, Prohibition of Unauthorized Injection	Underground injections are prohibited if they would allow movement of fluid containing any contaminant into underground sources of drinking water if the presence of that contaminant may cause a violation of any primary drinking water regulation or if they may adversely affect the health of persons. If the contaminant moves, corrective action would be required (see R315-7-5.5).	Yes/--	4, 5	This is the applicable substantive UIC program requirement for remedies involving air sparging, ISCO, and enhanced bioremediation injection wells.
	UAC R317-7-6.6, Class V Well Plugging and Abandonment Requirements	Establishes the requirements for closure of Class V injection wells.	Yes/--	4,5	Applicable UIC program requirement for the closure of injection wells.
The Air Force will comply with applicable state and federal laws for transporting of hazardous waste when transporting hazardous waste from Hill AFB					

**THIS PAGE INTENTIONALLY LEFT BLANK**



**Appendix B**  
**Proposed Plan Comments and**  
**U.S. Air Force Responses to Comments**

---

**THIS PAGE INTENTIONALLY LEFT BLANK**

## Appendix B – Introduction

---

Comments on the Proposed Plan and preferred remedy for OU 11 were solicited through the following actions:

- A notice of availability of the Proposed Plan and opportunity for public comment was published in the *Ogden Standard Examiner*
- A public meeting presenting the proposed remedy was held on 9 April 2014 at The Landing (Club Hill) at Hill AFB, Utah
- A public comment period for the Proposed Plan was held from 25 March to 23 April 2014
- Written comments by the public were encouraged

As discussed in the responsiveness summary, no comments were received from the public regarding the Proposed Plan.

This Appendix contains the following documents related to the public meeting and public comment period:

- Record of the public meeting held at The Landing (Club Hill) at Hill AFB, Utah on 9 April 2014
- Newspaper advertisement for the public meeting and public comment period, published in the *Ogden Standard Examiner* on 25 March 2014

**THIS PAGE INTENTIONALLY LEFT BLANK**

OPERABLE UNIT 11 INFOFAIR

HELD At HILL AIR FORCE BASE

APRIL 9, 2014

3:00 p.m.

REPORTED BY

RENEE L. STACY, RPR, CRR



333 SOUTH RIO GRANDE  
SALT LAKE CITY, UTAH 84101  
WWW.DEPOMAXMERIT.COM

TOLL FREE 800-337-6629  
PHONE 801-328-1188  
FAX 801-328-1189

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25

April 9, 2014

3:00 p.m.

The record was kept open from 3:00 to 5:00  
p.m. No public comments were made.

\* \* \* \*

1 STATE OF UTAH )  
2 COUNTY OF DAVIS ) ss.

3  
4 I, RENEE L. STACY, Registered Professional  
5 Reporter, Certified Realtime Reporter, and Notary  
6 Public for the State of Utah, certify:

7 That I was present at the foregoing  
8 Operable Unit 11 Infofair at the time and place  
9 herein set forth;

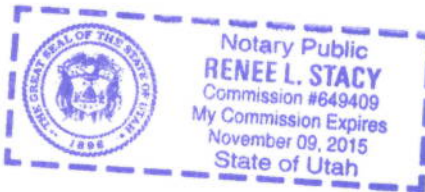
10 That there were no public comments made at  
11 this hearing;

12 IN WITNESS WHEREOF, I have subscribed my  
13 name and affixed my seal this 10th day of April,  
14 2014.

15  
16 *Renee L. Stacy*

17 RENE L. STACY, RPR, CRR  
18 Notary Public in and for the  
19 County of Salt Lake, State of Utah

20 My Commission Expires:  
21 November 9, 2015





**THIS PAGE INTENTIONALLY LEFT BLANK**



# Friends fundraise for mugged Layton woman with MS

She says she will accept amount stolen, donate remainder to charity

By ANDREAS RIVERA  
Standard-Examiner staff

Read more about Bentley and her brushes with domestic violence and homelessness  
[www.standard.net](http://www.standard.net)

LAYTON — Kamryn Bentley isn't one to let life get her down. Despite being diagnosed with multiple sclerosis and mobile only with a wheelchair, she considers herself very independent.

However, the adjustment to her new lifestyle hasn't been easy, and it was recently made worse by teenage bullies who robbed her.

Late Friday, Bentley was coming back from the Layton Kmart on Main Street with groceries when a car with a couple of teenagers drove by.

The teenagers shouted out the window, "Vegetable!"

This wasn't her first run-in with the "punks," so she shouted back at them and continued on her way home.

What she said she didn't expect was to get jumped by the two teens. One came up from behind and grabbed her wheelchair while the other appeared from behind some bushes.

"They just kept calling me 'vegetable' and 'retard,'" Bentley told the Standard-Examiner. "The kid in front kept saying, 'What are you going to do, get out of that chair?'"

She said they hit the flashlight she was carrying out of her hand, then took her shopping bag, which also had her wallet in it. The stretch of road they were on was dark, so they could have gone unnoticed by passing cars.

The attack lasted only a minute, but it seemed much longer to Bentley.

"I used to be really active, going everywhere, anywhere to get me out of the house," she said.

Now whenever Bentley leaves her home, the attack is in the back of her mind.

In her wallet was her ID, debit and credit cards, and \$220 she earned at a temp job.

Bentley is mostly supported by Social Security, but she said that isn't nearly enough to support her and her two children. The money she earned working was for medication and groceries.

When a network of friends and family heard about the robbery, a donation site was set up to help Bentley rebuild her finances.

Bentley said she doesn't want to throw a pity party, though. She is accepting only the amount of money that was stolen from her and donating the rest to a charity, to help others in her same situation.

As of Monday, the site had taken \$1,700 in donations.

"What I really want is for police to find and talk to those kids," she said, not just to get her belongings back, but to stop them from belittling anyone else.

Bentley isn't a fan of the attention, but she hopes her story can raise awareness and stop the bullying of those who have disabilities.

Although she may not be very mobile, she is active in advocacy and charity work. She recently shaved her long hair in support of a family member with cancer.

Before MS forced her into a wheelchair, she was studying to be a mortician and was working as an aide at the University of Utah Medical Center. After her diagnosis, things went downhill, and it's been a difficult path to adjust to her new life, but Bentley said she will continue moving forward and working to help others.

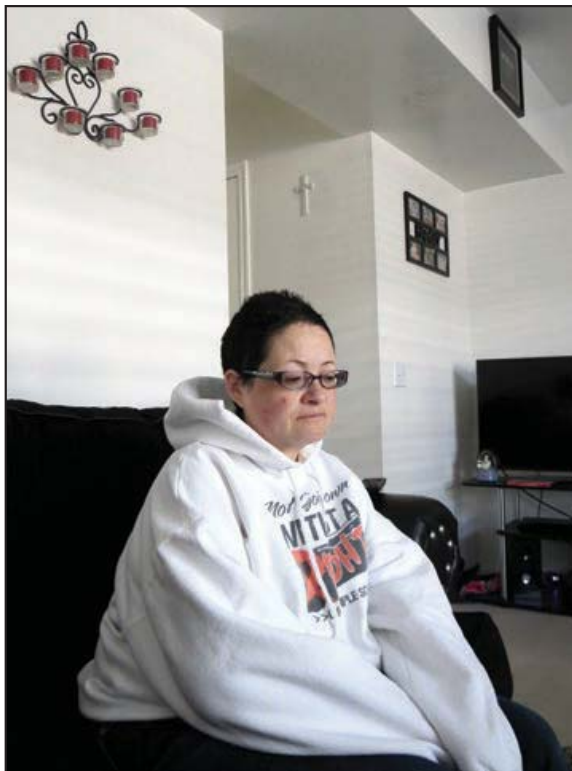
Police are still investigating the robbery and searching for the two teens involved. One of the teens is described as tall and thin with sandy blond hair and wearing a striped hoodie. Bentley did not get a good look at the other teen, who came up behind her.

They drove away in a dark blue or dark green minivan.

Anyone with information on the teenagers can call Layton police at 801-497-8300.

A direct link to donate to Bentley's fundraiser can be found with this article at [www.standard.net](http://www.standard.net).

Follow reporter *Andreas Rivera* at 801-625-4227 or [arivera@standard.net](mailto:arivera@standard.net). Follow him on Twitter at @SE\_Andreas.



See video online  
[www.standard.net](http://www.standard.net)

Kamryn Bentley recounts her ordeal

They drove away in a dark blue or dark green minivan.

Anyone with information on the teenagers can call Layton police at 801-497-8300.

A direct link to donate to Bentley's fundraiser can be found with this article at [www.standard.net](http://www.standard.net).

Follow reporter *Andreas Rivera* at 801-625-4227 or [arivera@standard.net](mailto:arivera@standard.net). Follow him on Twitter at @SE\_Andreas.

Kamryn Bentley, a Layton woman who has MS and uses a wheelchair, is hoping police find the teens who taunted and robbed her Friday. In the meantime, a donation site is available with proceeds going to help others with disabilities.

ANDREAS RIVERA/Standard-Examiner

Cleary has been building solid relationships for over 36 years for good reason — we treat our Clients like family.

**CALL US FOR A FREE CONSULTATION!**  
**Garland, UT**  
**435-257-4578**

**BUILDING SALE!**  
30'x40'x13' • \$15,565  
42'x72'x15' • \$27,750  
60'x104'x17' • \$55,475

Building pictured is not priced in ad. Crew travel required over 50 miles. Local building code modifications extra. Price subject to change without notice.  
800-373-5550 | [ClearyBuilding.com](http://ClearyBuilding.com)

FEATURING: **FABRAL**

The best way to search for Top of Utah businesses.

**utahfindit.com**  
restaurants | services | whatever

SEARCH 04/11/14

## Judge issues warrants for 2 witnesses who bail out on vehicle burglary case

By LORETTA PARK  
Standard-Examiner staff

LAYTON — A judge has issued \$100,000 warrants for two witnesses who failed to show up for a preliminary hearing.

Jake Lee Padilla, 30, who is charged with 21 counts relating to vehicle thefts and vehicle burglaries at Lagoon in July 2013, appeared in 2nd District Court in Layton for a preliminary hearing Monday.

But two witnesses never arrived, even though they were served with subpoenas to show up, Deputy Davis County Attorney Richard Larsen told Judge Robert Dale.

"Both of these witnesses were personally served with subpoenas," Larsen said. "One of them, Mr. Facio Nelson, was served twice, once at his last known address and again at a new address we were told about. They have failed to appear."

Padilla's attorney, Ryan Bushell, asked Dale to dismiss the charges without prejudice, which would allow prosecutors to refile the charges if the two witnesses are found.

Dale ordered material witness warrants for Facio Jerry Nelson and Alecia Nelson. He set April 30 for another preliminary hearing.

Padilla is serving a sentence at the Utah State Prison on unrelated charges.

According to court documents, last July,

Padilla stole at least one vehicle from Lagoon's parking lot, Farmington police believe. The vehicle was found later in Salt Lake County.

Padilla was originally charged with one count of theft, but in February, prosecutors filed amended charges adding 20 counts.

Padilla is charged with one count of pattern of unlawful activity, a second-degree felony; 13 counts of theft, six counts of which are second-degree felonies and seven counts are third-degree felonies; and seven counts of vehicle burglaries, class A misdemeanors.

Larsen said after Monday's hearing that the reason his office filed amended charges is because, as police continued to investigate, they found Padilla either had in his possession or with his property many items that had been reported stolen in July from not only Lagoon, but also from Centerville and other areas.

Larsen said he could not get into the specifics of the case, saying those specifics will be addressed at the preliminary hearing.

Contact reporter *Loretta Park* at 801-625-4252 or [lpark@standard.net](mailto:lpark@standard.net). Follow her on Twitter at @LorettaParkSE.



Padilla

**Public Comment Opportunity**  
March 25 to April 23, 2014

The Air Force is accepting comments on the Proposed Plan for cleanup at Hill Air Force Base Operable Unit 11 located on-base near the Autopride gas station. The source of OU-11 was a former gas station located in the parking area of the current gas station. The groundwater is contaminated with three different types of contaminants:

- Solvents - trichloroethene (TCE)
- Gasoline constituents - benzene, toluene, ethylbenzene, xylenes and naphthalene (BTEXN)
- Fuel additive - methyl tertiary butyl ether (MTBE)

An area of soil is also contaminated with fuels that are floating on the water table.

**OU-11 Proposed Plan calls for:**

- **Groundwater remedy:** Installation of four deep extraction wells in the 75th FSS Customer Support Element parking lot (Building 430, next to the Commissary). During installation of the extraction wells, the parking lot may be significantly impacted.
- **Soil remedy:** Soil vapor extraction (SVE) to remove contaminant vapors from within the soil to prevent further contamination of the groundwater. Fuel recovery will also be conducted to remove the fuel floating on the water table.

**OU-11 Proposed Plan Public Meeting**  
April 9, 2014  
3-5 p.m.  
The Landing (Club Hill)  
7420 Miller St., Bldg 450  
Hill AFB, UT

**Comment in person at the public meeting, or write to:**  
Shannon Smith  
AFCEC/CZOM  
7274 Wardleigh Road, Bldg 5, Bay U  
Hill AFB, UT 84056-5137  
**Or via e-mail:**  
[shannon.smith.2@us.af.mil](mailto:shannon.smith.2@us.af.mil)  
All comments must be postmarked by midnight April 23, 2014. Media representatives may contact George Jozens at (801) 777-1902.

**Review Proposed Plan at:**  
**Internet**  
■ [www.hillrab.org/OU11ProposedPlan](http://www.hillrab.org/OU11ProposedPlan)  
**Weber State University**  
■ Stewart Library, Ogden Campus (For hours, call 801-626-6403)  
■ Davis Campus Library, Layton (For hours, call 801-395-3472)

**PRIME RIB BUSINESS LUNCH**

**FAST**

**FULL MENU  
SERVED ALL DAY  
BEAUTIFUL  
ATMOSPHERE**

**RICKENBACKER'S STEAK HOUSE**

Ogden-Hinckley Airport, Gateway Center  
4282 S. 1650 W. • Ogden, Utah 84405 • 801.627.4100  
[www.rickenbackerssteakhouse.com](http://www.rickenbackerssteakhouse.com)

Come for the "Food" - Stay for the "View"

Buy local FIRST UTAH

Twitter icon

Facebook icon

**A Golf Course Quality Lawn Can Be Yours!**

Become self-sufficient this year and save up to 50% off the cost of commercial lawn services!

**J&J's DO-IT-YOURSELF 5 STEP FERTILIZER PROGRAM**

Step 1- March 1 to April 15 - apply Basin's Best\* Lawn Guard Fertilizer with Pre-Emergent 19-3-5

Step 2- April 15 to May 15 - apply Utah's Finest\* 24-5-10 Slow Release Fertilizer 25% SCU

Step 3- May 1 to June 1 - apply Speed Zone for weed control (or when weeds are present and actively growing)

Step 4- June 1 to June 15 - second application of Basin's Best\* Lawn Guard Fertilizer with Pre-Emergent 19-3-5

Step 5- July 15 to August 30 - apply Utah's Finest\* 23-3-16 Fertilizer 60% SCU \*Available exclusively at J&J Garden Center  
**Dates may vary depending on weather!**

Follow our proven formula for a healthy and gorgeous lawn!

**J&J'S FIVE-STEP PACKAGE COST**  
**\$129.98**  
Regular Price \$150.90 - Save \$20.92

**EACH APPLICATION COVERS UP TO 10,000 SQ. FT.**

**Store Hours - Mon.-Sat. 8am-7pm**  
1815 W. Gentile Street, Layton - 801-544-1211 - [www.jjnursery.com](http://www.jjnursery.com)

**J&J NURSERY and GARDEN CENTER**  
Country Grown to Your Home



**THIS PAGE INTENTIONALLY LEFT BLANK**